Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with SAE's Proposed 3D Seismic Surveys in Cook Inlet, Alaska, 2015

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1. DESCRIPTION OF SPECIFIED ACTIVITY

SAExploration, Inc. (SAE) plans to conduct three-dimensional (3D) nodal or ocean-bottom node (OBN) seismic surveys in state and federal waters within upper and lower Cook Inlet during the open water season of 2015. The program is intended to obtain marine offshore data by mapping the subsurface and its geological structure for oil and gas pockets. Because SAE will use seismic air guns as the source, this operation could acoustically harass local marine mammals. Harassment is a form of “take” as defined under the Marine Mammal Protection Act (MMPA), and is subject to governance under MMPA. Incidental and unintentional harassment “takes” are permitted with the issuance of an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS). MMPA identifies 14 specific items that must be addressed when applying for an IHA, which allow NMFS to fully evaluate whether or not the proposed actions remain incidental and unintentional. The 14 items are addressed below relative to the 2015 offshore component of this seismic survey program.

This IHA application addresses marine mammals under the jurisdiction of NMFS only. Sea otters (*Enhydra lutris*) are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and are addressed under a separate IHA application.

Overview of Activity

The planned 3D seismic survey would occur over multiple years in the marine waters of both upper and lower Cook Inlet. The ultimate survey area is divided into two units (upper and lower Cook Inlet). Upper Cook (2,126 square kilometers; 821 square miles) begins at the line delineating Cook Inlet beluga whale (*Delphinapterus leucas*) Critical Habitat Area 1 and 2, south to a line approximately 10 kilometers (6 miles) south of both the West Foreland and East Foreland (Figure 1). Lower Cook (1,808 square kilometer; 698 square mile) begins east of Kalgin Island and running along the east side of lower Cook Inlet to Anchor Point (Figure 2). The total potential survey area is 3,934 square kilometers (1,519 square miles); however, only a portion (currently unspecified) of this area will ultimately be surveyed, and no more than 777 square kilometers (300 square miles) in a given year. The exact location of where the 2015 survey will be conducted is not known at this time, and probably will not be known until spring 2015 when SAE’s clients have finalized their data acquisition needs.

The components of the project include laying recording sensors (nodes) on the ocean floor, operating seismic source vessels towing active air gun arrays, and retrieval of nodes. There will also be additional boat activity associated with crew transfer, recording support, and additional monitoring for marine mammals.

Phases of the operation and equipment specifics are addressed individually below.

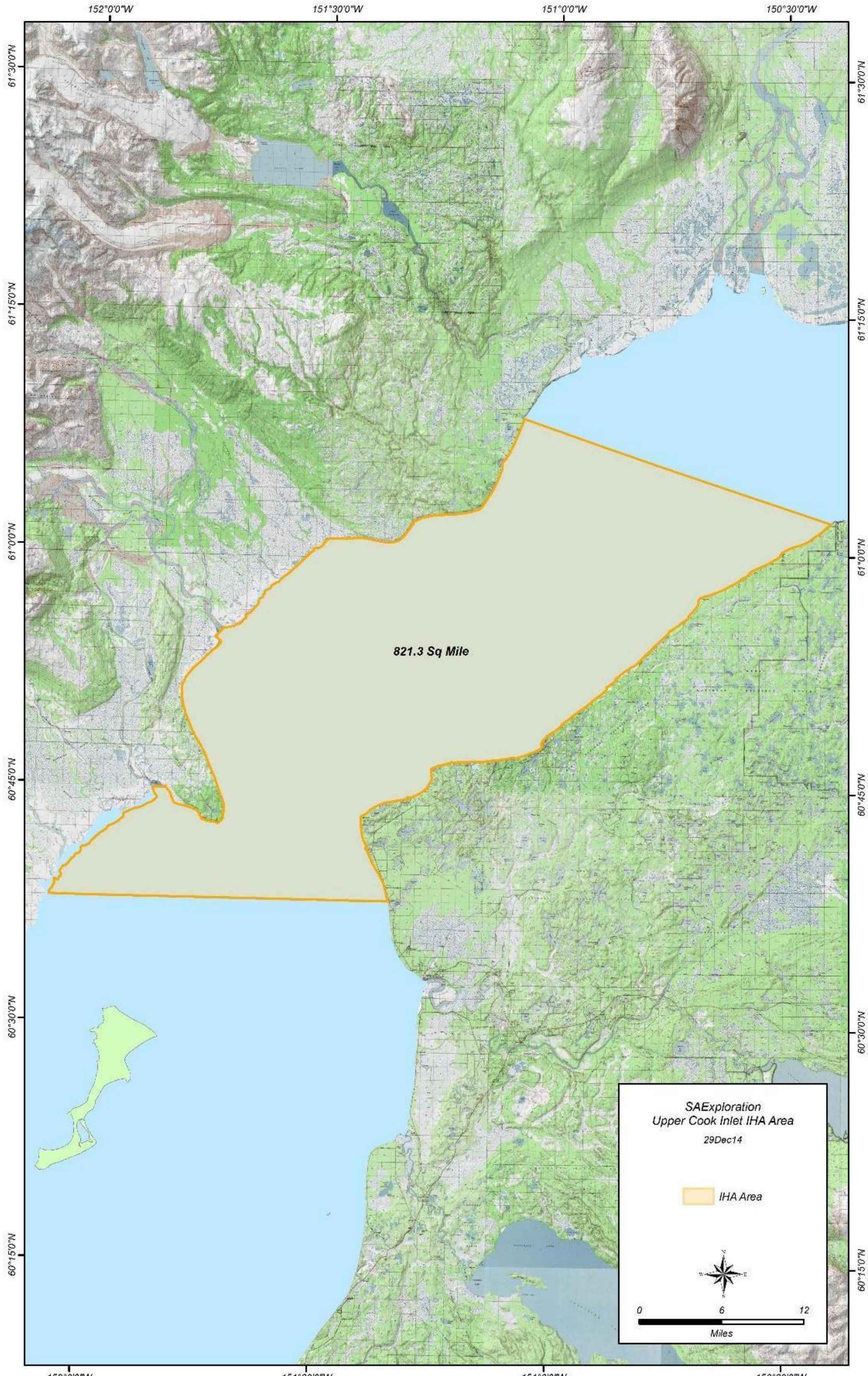

Figure 1. Proposed upper Cook Inlet seismic survey area.

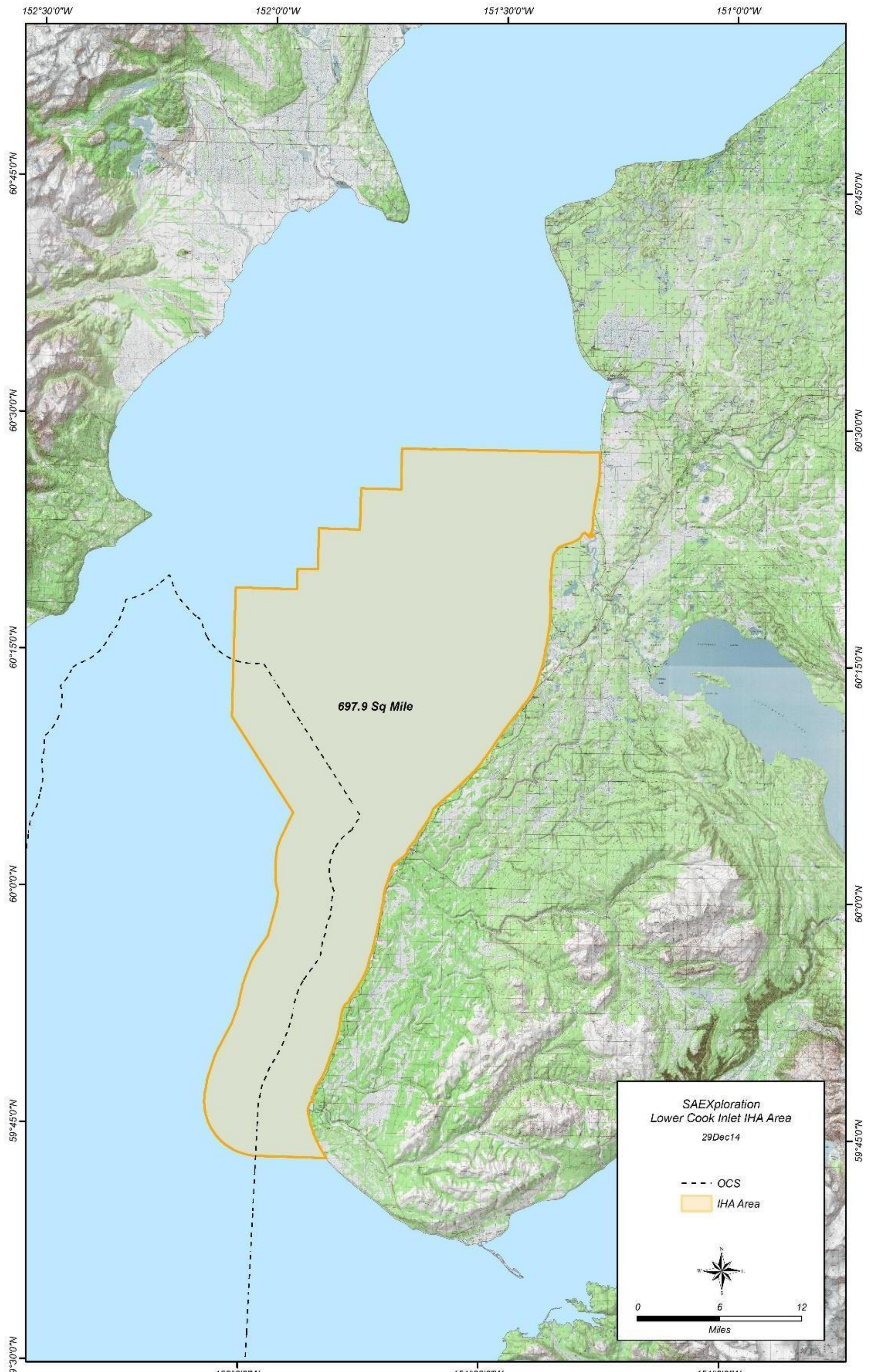

Figure 2. Proposed lower Cook Inlet seismic survey area.

Project Details

Survey Design

Marine seismic operations will be based on a “recording patch” or similar approach. Patches are groups of six receiver lines and 32 source lines (Figure 3). Each receiver line has submersible marine sensor nodes tethered (with non-kinking, non-floating line) equidistant (50 meters; 165 feet) from each other along the length of the line. Each node is a multicomponent system containing three velocity sensors and a hydrophone (Figure 4). Each receiver line is approximately 8 kilometers (5 miles) in length, and are spaced approximately 402 meters (1,320 feet) apart. Each receiver patch is 19.4 square kilometers (7.5 square miles) in area. The receiver patch is oriented such that the receiver lines run parallel to the shoreline.

The 32 source lines, 12 kilometers (7.5 miles) long and spaced 502 meters (1,650 feet) apart, run perpendicular to the receiver lines (and perpendicular to the coast) and, where possible, will extend approximately 5 kilometers (3 miles) beyond the outside receiver lines and approximately 4 kilometers (2.5 miles) beyond each of the ends of the receiver lines. The outside dimensions of the maximum shot area during a patch shoot will be 12 kilometers by 16 kilometers (7.5 miles by 10 miles), with an area of 192 square kilometers (75 square miles). All shot areas will be wholly contained within the survey boxes depicted in Figures 1 and 2. Shot intervals along each source line will be 50 meters (165 feet).

It may take a period of 3 to 5 days to deploy, shoot, and record a single receiver patch. On average, approximately 49 square kilometers (18.75 square miles) of patch will be shot daily. During recording of one patch, nodes from the previously surveyed patch will be retrieved, recharged, and data downloaded prior to redeployment of the nodes to the next patch. As patches are recorded, receiver lines are moved side to side or end to end to the next patch location so that receiver lines have continuous coverage of the recording area.

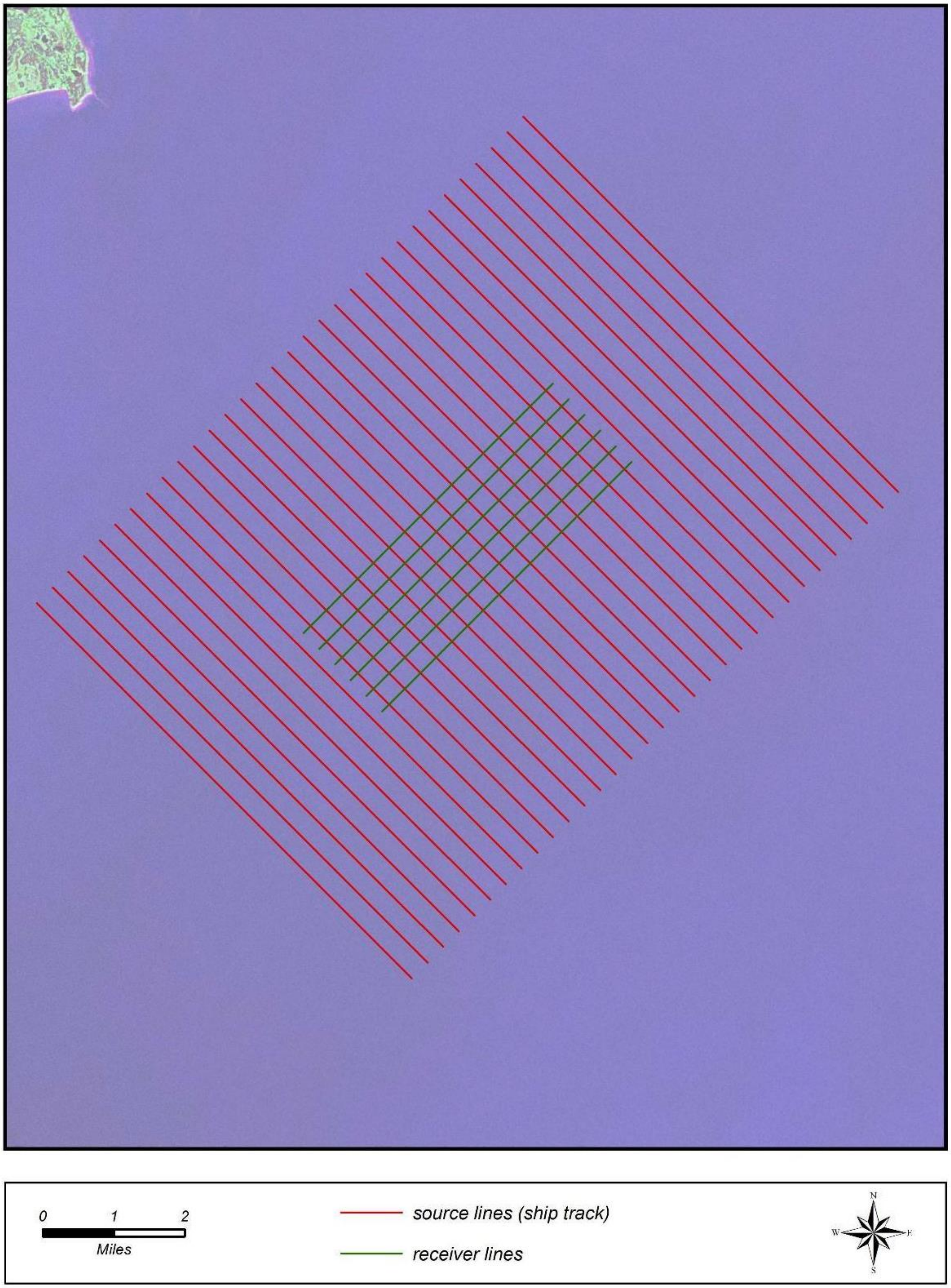

Figure 3. Typical patch layout.

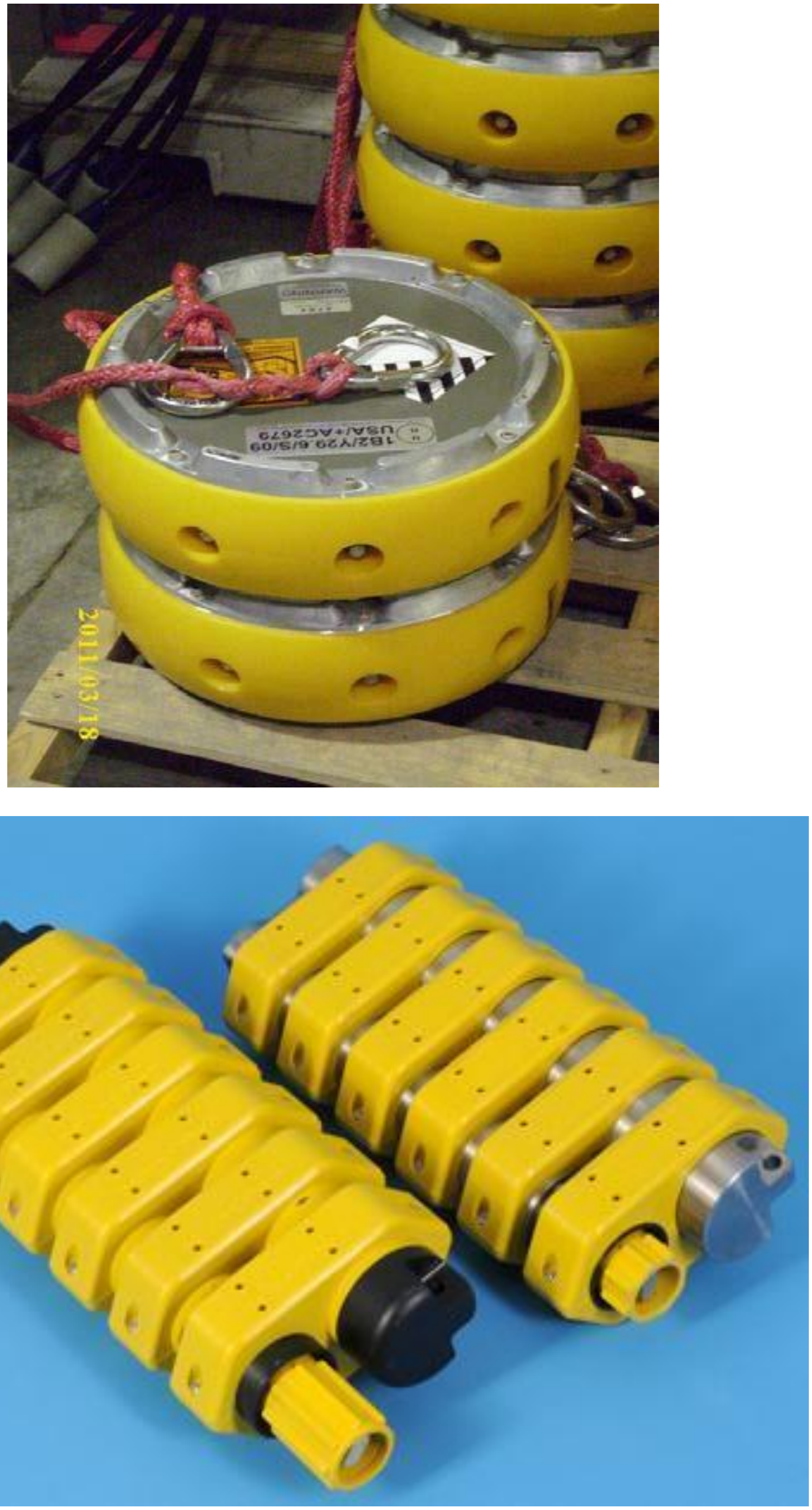

Figure 4. Example nodes.

Autonomous recording nodes lack cables but will be tethered together using a thin rope for ease of retrieval. This non-floating, non-kinking rope will lay on the seabed surface, as will the nodes, and will have no effect on marine traffic. Primary vessel positioning will be achieved using GPS with the antenna attached to the air gun array. Pingers deployed from the node vessels will be used for positioning of nodes. The geometry/patch could be modified as operations progress to improve sampling and operational efficiency.

Acoustical Sources

Airguns are the acoustic sources of primary concern and will be deployed from the seismic vessels. However, there are other noise sources to be addressed. These include the pingers and transponders associated with locating receiver nodes, as well as propeller noise from the vessel fleet.

Seismic Source Array

The primary seismic source for offshore recording consists of a 2 x 880-cubic-inch tri-cluster array for a total of 1,760-cubic-inches (although a 440-cubic-inch array may be used in very shallow water locations as necessary). Each of the arrays will be deployed in a configuration outlined in Appendix A. The arrays will be centered approximately 15 meters (50 feet) behind the source vessel stern, at a depth of 4 meters (12 feet), and towed along predetermined source lines at speeds between 7.4 and 9.3 kilometers per hour (4 and 5 knots). Two vessels with full arrays will be operating simultaneously in an alternating shot mode; one vessel shooting while the other is recharging. Shot intervals are expected to be about 16 seconds for each array resulting in an overall shot interval of 8 seconds considering the two alternating arrays. Operations are expected to occur 24 hours a day, with actual daily shooting to total about 12 hours.

Based on the manufacturer's specifications, the 1,760-cubic-inch array has a peak-peak estimated sound source of 254.55 dB (decibels) re 1 micropascals (μPa) @ 1 m (53.5 bar-m; Far-field Signature, Appendix A), with a root mean square (rms) sound source of 236.55 dB re 1 μPa. The manufacturer-provided source directivity plots for the three possible airgun arrays are shown in Appendix A. They clearly indicate that the acoustical broadband energy is concentrated along the vertical axis (focused downward), while there is little energy focused horizontally. The spacing between airguns results in offset arrival timing of the sound energy. These delays "smear" the sound signature as offset energy waves partially cancel each other, which reduces the amplitude in the horizontal direction. Thus, marine mammals near the surface and horizontal to the airgun arrays would receive sound levels considerably less than a marine mammal situated directly beneath the array, and at levels probably less than predicted by the acoustical spreading model. As a result, the estimates of the distances to NMFS Level A and B "take" criterion determined for this IHA request should be considered conservative.

Airgun arrays typically produce most noise energy in the 10- to 120-hertz range, with some energy extending to 1 kilohertz (kHz) (Richardson *et al*. 1995). This sound energy is well within the hearing range of baleen whales (Richardson *et al*. 1995), but well below the effective hearing range of pinnipeds (10 to 30 kHz; Schusterman 1981) and odontocetes (12 to ~100 kHz; Wartzok and Ketten 1999). Richardson *et al*. (1995) found little evidence of pinnipeds and odontocetes reacting to seismic pulses, suggesting pinnipeds are tolerant to these types of noise and odontocetes have difficulty hearing the low frequency energy. It is assumed, however, that SAE's airgun pulses will be audible to local pinnipeds and odontocetes given the high energy involved, but would more likely elicit reaction from baleen whales, such as minke and humpback whales, than the high frequency species. Specific impacts from airguns is addressed further in Section 7.

Transceivers and Transponders

An acoustical positioning (or pinger) system will be used to position and interpolate the location of the nodes. A vessel-mounted transceiver calculates the position of the nodes by measuring the range and bearing from the transceiver to a small acoustic transponder fitted to every third node. The transceiver uses sonar to interrogate the transponders, which respond with short pulses that are used in measuring the range and bearing. The system provides a precise location of every node as needed for accurate interpretation of the seismic data. The transceiver to be used is the Sonardyne Scout USBL, while transponders will be the Sonardyne TZ/OBC Type 7815-000-06. Because the transceiver and transponder communicate via sonar, they produce underwater sound levels. The Scout USBL transceiver has a transmission source level of 197 dB re 1 μPa (rms) and operates at frequencies between 35 and 55 kHz. The transponder produces short pulses of 184 to 187 dB re 1 μPa (rms) at frequencies also between 35 and 55 kHz.

Both transceivers and transponders produce noise levels just above or within the most sensitive hearing range of seals (10 to 30 kHz; Schusterman 1981) and odontocetes (12 to ~100 kHz; Wartzok and Ketten 1999), and the functional hearing range of baleen whales (20 Hz to 30 kHz; National Research Council [NRC] 2003); although baleen whale hearing is probably most sensitive nearer 1 kHz (Richardson *et al*. 1995). However, given the low acoustical output, the range of acoustical harassment to marine mammals (for the 197 dB transceiver) is about 100 meters (328 feet), or significantly less than the output from the airgun arrays, and is not loud enough to reach injury levels in marine mammals beyond 9 meters (30 feet). Marine mammals are likely to respond to pinger systems similar to airgun pulses, but only when very close (a few meters) to the sources.

Vessels

Several offshore vessels will be required to support recording, shooting, and housing in the marine and transition zone environments. Exact vessels to be used have not been determined, but similar vessel types typically used to fulfill these roles are found in Table 1.

Table 1. Vessels planned to be used during SAE's 2015 seismic survey program.

Operation	Size (feet)	Gross Tonnage	No. of Berths	Main Activity/Frequency	Source Levels* (dB)
Source Vessel	135 x 38	251	22	Seismic data acquisition 24 hour operation	200.1
Source Vessel	99 x 24	100	18	Seismic data acquisition 24 hour operation	179.0
Node equipment deployment and retrieval	85 x 20	80	6	Deploying and retrieving nodes 24 hour operation	165.3
Node equipment deployment and retrieval	85 x 24	80	16	Deploying and retrieving nodes 24 hour operation	165.3
Node equipment deployment and retrieval	70 x 16	48	10	Deploying and retrieving nodes 24 hour operation	165.3
Mitigation/Housing Vessel	85 x 23	100	32	House crew 24 hour operation	200.1
Crew Transport Vessel	30 x 20	20-30	3	Transport crew intermittent 8 hours	191.8
Bow Picker	32 x 14	48	1	Deploying and retrieving nodes Intermittent operation	171.8
Bow Picker	30 x 20	20-30	3	Deploying and retrieving nodes Intermittent operation	171.8

**Sound source levels from Aerts et al. (2008) based on empirical measurements of the same vessels expected to be used during this survey.*

Source Vessels

Source vessels will have the ability to deploy two arrays off the stern using large A- frames and winches and have a draft shallow enough to operate in waters less than 1.5 meters (5 feet) deep. On the source vessels, the airgun arrays are typically mounted on the stern deck with an umbilical that allow the arrays to be deployed and towed from the stern without having to re-rig or move arrays. The two marine vessels that have been used in the past are the *Peregrine Falcon* and *Arctic Wolf*. Both vessels "acoustic signatures" were measured by Aerts *et al*. (2008) and have a source levels of 179.0 dB re 1 μPa (rms) and 200.1 dB re 1 μPa (rms), respectively.

Recording Deployment and Retrieval

Jet-driven shallow draft vessels and bow-pickers will be used for the deployment and retrieval of the offshore recording equipment. These vessels will be rigged with hydraulically driven deployment and retrieval equipment allowing for automated deployment and retrieval from the bow or stern of the vessel. Aerts *et al*. (2008) found the recording and deployment vessels to have source levels of approximately 165.3 dB re 1 μPa (rms), while the smaller bow pickers produce more cavitation resulting in source levels of 171.8 dB re 1 μPa (rms).

Housing and Transfer Vessels

Housing vessel(s) will be larger with sufficient berthing to house crews and management. The housing vessel will have ample office and bridge space to facilitate the role as the mother ship and central operations. Crew will be largely housed aboard the source vessel *Arctic Wolf* and the mitigation vessel *Dreamcatcher* (or similar vessels), both with large numbers of berths. The crew transfer vessels (*Gwyder Bay* or similar) will be sufficiently large to safely transfer crew between vessels as needed. The crew transfer vessel travels infrequently relative to other vessels and is operated at different speeds. During high-speed runs to shore, the *Gwyder Bay* was found to produce source noise levels of about 191.8 dB re 1 μPa (rms), while during slower on-site movements the vessel source levels were only 166.4 dB re 1 μPa (rms) (Aerts *et al*. 2008).

Mitigation Vessel

To facilitate marine mammal monitoring of the Level B harassment zone, one dedicated vessel will be deployed a few kilometers from the active seismic source vessels to provide a survey platform for two or three Protected Species Observers (PSO). These PSOs will work in concert with PSOs stationed aboard the source vessels, and will provide an early warning of the approach of any marine mammals. The *Dreamcatcher* or a similar boat, will fulfill this role. There is no available acoustic signature for the *Dreamcatcher,* but it is similar in size to the *Peregrine Falcon* and therefore is expected to have a similar source sound level (179.0 dB re 1 μPa [rms]).

Maintaining Safe Radii

The seismic airguns that will be used during SAE's Cook Inlet operation have the potential to acoustically injure marine mammals at close proximity. These Level A "takes" are not authorized by IHAs and measures must be taken to avoid them. The NMFS criteria for Level A "take" are 180 dB for whales and 190 dB for seals (all rms). To avoid exposing marine mammals to these received noise levels, safety zones will be established based on the zones of influence (ZOIs; the area ensonified by a specific sound level) for the 440- (221.1 dB source) and 1,760- (236.55 dB source) cubic-inch airgun arrays. In 2014, Heath *et al*. (2014) conducted a sound source verification of the very same 440- and 1,760-cubic-inch arrays SAE plans to use in 2015. They empirically determined that the distances to the 190 and 180 dB isopleths for sound pressure levels emanating from the 440-cubic-inch array was 50 and 182 meters, respectively (Table 2). Distances to these isopleths when operating the 1,760-cubic-inch array varied with water depth. In shallow waters less than 15 meters (49 feet) deep the distances to the 190 and 180 dB isopleths were 830 meters and 1.53 kilometers, respectively, while for waters greater than 15 meters (49 feet) deep, the distances were 880 and 1.84 kilometers, respectively (Table 2).

Qualified PSOs will be deployed aboard the seismic vessels to monitor the safety zones (see Appendix B, Marine Mammal Monitoring and Mitigation Plan), and alert operations to shut down at the approach of a marine mammal to these safety zones.

Table 2: Injury Exclusion Zone (Level A) radii for pinnipeds (190 dB) and cetaceans (180 dB) for each airgun array.

Array (cubic inch)	Water Depth	190 dB radius (m)	180 dB radius (m)
440	Very Shallow	50	182
1,760	Shallow	830	1,530
1,760	Deep	880	1,840

While the pingers and transponders that will be used to relocate nodes generate source sound levels (185 to 193 dB) exceed Level A criteria, the associated ZOIs are small (radii of 0 to 6 meters) making marine mammal monitoring impractical (a 6-meter radius equates to only a 113-square-meter ZOI, of which more than half the area would be occupied by the deployment boat). PSOs and operators will, however, ensure that no marine mammals are in the immediate vicinity before deploying active pingers and transponders.

Housing and crew transfer vessels can produce noises exceeding 190 or 180 dB re 1 μPa (rms) when traveling at higher speeds. However, ZOIs only extend to 2 to 4 meters from the vessel; again, an area impractical to monitor.

2. DATES, DURATION, AND SPECIFIC GEOGRAPHICAL REGION

The request for incidental harassment authorization is for the 2015 Cook Inlet open water season (March 1 to December 15). All associated activities, including mobilization, survey activities, and demobilization of survey and support crews, would occur inclusive of the above dates. The plan is to conduct seismic surveys in the Upper Cook unit sometime between March 1 and December 15. The northern border of the seismic survey area depicted in Figure 1 takes into account the restriction that no activity occur between April 15 to October 15 in waters within 16 kilometers (10 miles) of the Susitna Delta (defined as the nearshore area between the mouths of the Beluga and the Little Susitna rivers). A small wedge of the upper Cook unit falls within 16 kilometers of the Beluga River mouth, but it is unlikely that SAE would be requested to survey this area. If they were, survey here would occur after October 15. The exact survey dates in a given unit will depend on ice conditions, timing restrictions, and other factors. If the upper Cook Inlet seismic surveys are delayed by spring ice conditions, some survey may occur in lower Cook Inlet from March to May to maximize use of the seismic fleet. Actual data acquisition is expected to occur for only 2 to 3 hours at a time during each of the 3 to 4 daily slack tides. Thus, it is expected that the airguns would operate an average of about 8 to 10 total hours per day. It is estimate that it will take 160 days to complete both the upper and lower Cook units, and that no more than 777 square kilometers (300 square miles) of survey area will be shot in 2015.

3. SPECIES AND NUMBERS OF MARINE MAMMALS

Marine mammals most likely to be found in the upper Cook activity area are the beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), and harbor seal (*Phoca vitulina*). However, these species are found there in low numbers, and generally only during the summer fish runs (Nemeth *et al*. 2007, Boveng *et al*. 2012). These species are also found in the Lower Cook survey area along with humpback whales (*Megaptera novaeangliae*), minke whales (*Balaenoptera acutorostra*), gray whales (*Eschrichtius robustus*), killer whales (*Orcinus orca*), Dall's porpoise (*Phocoenoides dalli*), and Steller sea lions (*Eumetopia jubatus*). Minke whales have been considered migratory in Alaska (Allen and Angliss 2014) but have recently been observed off Cape Starichkof and Anchor Point year-round. Humpback and gray whales are probably seasonal in Lower Cook, while the remaining species could be encountered at any time of the year. During marine mammal monitoring conducted off Cape Starichkof between May and August 2013, observers recorded small numbers of humpback whales, minke whales, gray whales, killer whales, and Steller sea lions, and moderate numbers of harbor porpoises and harbor seals (Owl Ridge 2014). This survey also recorded a single beluga observed 6 kilometers north of Cape Starichkof in August 2013. The stock populations for non-listed marine mammals found in Cook Inlet are shown in Table 3.

Table 3. Marine mammals inhabiting the Cook Inlet action area.

Species	Stock Estimate	Comment
Humpback Whale (*Megaptera novaeangliae*)	7,469	Central North Pacific Stock, ESA-listed as Endangered
Minke Whale (*Balaenoptera acutorostra*)	1,233	Alaska Stock
Gray Whale (*Eschrichtius robustus*)	19,126	Eastern North Pacific Stock
Beluga Whale (*Delphinapterus leucas*)	312	Cook Inlet Stock, ESA-listed as Endangered
Killer Whale (*Orcinus orca*)	2,347	Alaska Resident Stock
Killer Whale (*Orcinus orca*)	587	Alaska Transient Stock
Harbor Porpoise (*Phocoena phocoena*)	31,046	Gulf of Alaska Stock
Dall's Porpoise *(Phocoenoides dalli*)	83,400	Alaska Stock
Harbor Seal (*Phoca vitulina*)	22,900	Cook Inlet/Shelikof Stock
Steller Sea Lion (*Eumetopia jubatus*)	45,649	Western U.S. Stock, ESA-listed as Endangered

Source: Allen and Angliss (2014), Carretta *et al*. (2013), Zerbini *et al*. (2006)

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

Humpback Whale (*Megaptera novaeangliae*)

Although there is considerable distributional overlap in the humpback whale stocks that use Alaska, the whales seasonally found in lower Cook Inlet are probably of the Central North Pacific stock. Listed as endangered under the Endangered Species Act (ESA), this stock has recently been estimated at 7,469, with the portion of the stock that feeds in the Gulf of Alaska estimated at 2,845 animals (Allen and Angliss 2014). The Central North Pacific stock winters in Hawaii and summers from British Columbia to the Aleutian Islands (Calambokidis *et al*. 1997), including Cook Inlet.

Humpback use of Cook Inlet is largely confined to lower Cook Inlet. They have been regularly seen near Kachemak Bay during the summer months (Rugh *et al*. 2005a), and there is a whale-watching venture in Homer capitalizing on this seasonal event. There are anecdotal observations of humpback whales as far north as Anchor Point, with recent summer observations extending to Cape Starichkof (Owl Ridge 2014). Humpbacks might be encountered in the vicinity of Anchor Point if seismic operations were to occur off the point during the summer. However, SAE plans, for the most part, to limit seismic activity along the Kenai Peninsula to during the spring and fall.

Minke Whale (*Balaenoptera acutorostra*)

Minke whales are the smallest of the rorqual group of baleen whales reaching lengths of up to 35 feet. They are also the most common of the baleen whales, although there are no population estimates for the North Pacific, although estimates have been made for some portions of Alaska. Zerbini *et al*. (2006) estimated the coastal population between Kenai Fjords and the Aleutian Islands at 1,233 animals.

During Cook Inlet-wide aerial surveys conducted from 1993 to 2004, minke whales were encountered only twice (1998, 1999), both times off Anchor Point 16 miles northwest of Homer. A minke whale was also reported off Cape Starichkof in 2011 (A. Holmes, pers. comm.) and 2013 (E. Fernandez and C. Hesselbach, pers. comm.), suggesting this location is regularly used by minke whales, including during the winter. Recently, several minke whales were recorded off Cape Starichkof in early summer 2013 during exploratory drilling conducted there (Owl Ridge 2014). There are no records north of Cape Starichkof, and this species is unlikely to be seen in upper Cook Inlet. There is a chance of encountering this whale during seismic operations along the Kenai Peninsula in lower Cook Inlet.

Gray Whale (*Eschrichtius robustus*)

Each spring, the Eastern North Pacific stock of gray whale migrate 8,000 kilometers (5,000 miles) northward from breeding lagoons in Baja California to feeding grounds in the Bering and Chukchi seas, reversing their travel again in the fall (Rice and Wolman 1971). Their migration route is for the most part coastal until they reach the feeding grounds. A small portion of whales do not annually complete the full circuit, as small numbers can be found in the summer feeding along the Oregon, Washington, British Columbia, and Alaskan coasts (Rice *et al*. 1984, Moore *et al*. 2007).

Human exploitation reduced this stock to an estimated "few thousand" animals (Jones and Schwartz 2002). However, by the late 1980s, the stock was appearing to reach carrying capacity and estimated to be at 26,600 animals (Jones and Schwartz 2002). By 2002, that stock had been reduced to about 16,000 animals, especially following unusually high mortality events in 1999 and 2000 (Allen and Angliss 2014). The stock has continued to grow since then and is currently estimated at 19,126 animals with a minimum estimate of 18,017 (Carretta *et al*. 2013).

Most gray whales migrate past the mouth of Cook Inlet to and from northern feeding grounds. However, small numbers of summering gray whales have been noted by fisherman near Kachemak Bay and north of Anchor Point. Further, summering gray whales were seen offshore of Cape Starichkof by marine mammal observers monitoring Buccaneer's Cosmopolitan drilling program in 2013 (Owl Ridge 2014). Regardless, gray whales are not expected to be encountered in upper Cook Inlet, where there are no records, but might be encountered during seismic operations along the Kenai Peninsula south of Ninilchik. However, seismic surveys are not planned in this region during the summer months when gray whales would be most expected.

Beluga Whale (*Delphinapterus leucas*)

The Cook Inlet beluga whale Distinct Population Stock (DPS) is a small geographically isolated population that is separated from other beluga populations by the Alaska Peninsula. The population is genetically (mtDNA) distinct from other Alaska populations suggesting the Peninsula is an effective barrier to genetic exchange (O'Corry-Crowe *et al*. 1997) and that these whales may have been separated from other stocks at least since the last ice age. Laidre *et al*. (2000) examined data from more than 20 marine mammal surveys conducted in the northern Gulf of Alaska and found that sightings of belugas outside Cook Inlet were exceedingly rare, and these were composed of a few stragglers from the Cook Inlet DPS observed at Kodiak Island, Prince William Sound, and Yakutat Bay. Several marine mammal surveys specific to Cook Inlet (Laidre *et al*. 2000, Speckman and Piatt 2000), including those that concentrated on beluga whales (Rugh *et al*. 2000, 2005a), clearly indicate that this stock largely confines itself to Cook Inlet. There is no indication that these whales make forays into the Bering Sea where they might intermix with other Alaskan stocks.

The Cook Inlet beluga DPS was originally estimated at 1,300 whales in 1979 (Calkins 1989) and has been the focus of management concerns since experiencing a dramatic decline in the 1990s. Between 1994 and 1998 the stock declined 47 percent and is attributed to overharvesting by subsistence hunting. Subsistence hunting was estimated to annually remove 10 to 15 percent of the population during this period. Only five belugas have been harvested since 1999, yet the population has continued to decline, with the most recent estimate at only 312 animals (Allen and Angliss 2014). NMFS listed the population as "depleted" in 2000 as a consequence of the decline, and as "endangered" under the Endangered Species Act (ESA) in 2008 when the population failed to recover following a moratorium on subsistence harvest. In April 2011, NMFS designated critical habitat for the beluga under the ESA (Figure 5).

Prior to the decline, this DPS was believed to range throughout Cook Inlet and occasionally into Prince William Sound and Yakutat (Nemeth *et al*. 2007). However the range has contracted coincident with the population reduction (Speckman and Piatt 2000). During the summer and fall beluga whales are concentrated near the Susitna River mouth, Knik Arm, Turnagain Arm, and Chickaloon Bay (Nemeth *et al*. 2007) where they feed on migrating eulachon (*Thaleichthys pacificus*) and salmon (Onchorhyncus spp.) (Moore *et al*. 2000). Critical Habitat Area 1 reflects this summer distribution (Figure 5). During the winter, beluga whales concentrate in deeper waters in the mid-inlet to Kalgin Island, and in the shallow waters along the west shore of Cook Inlet to Kamishak Bay (Critical Habitat Area 2; Figure 5). Some whales may also winter in and near Kachemak Bay.

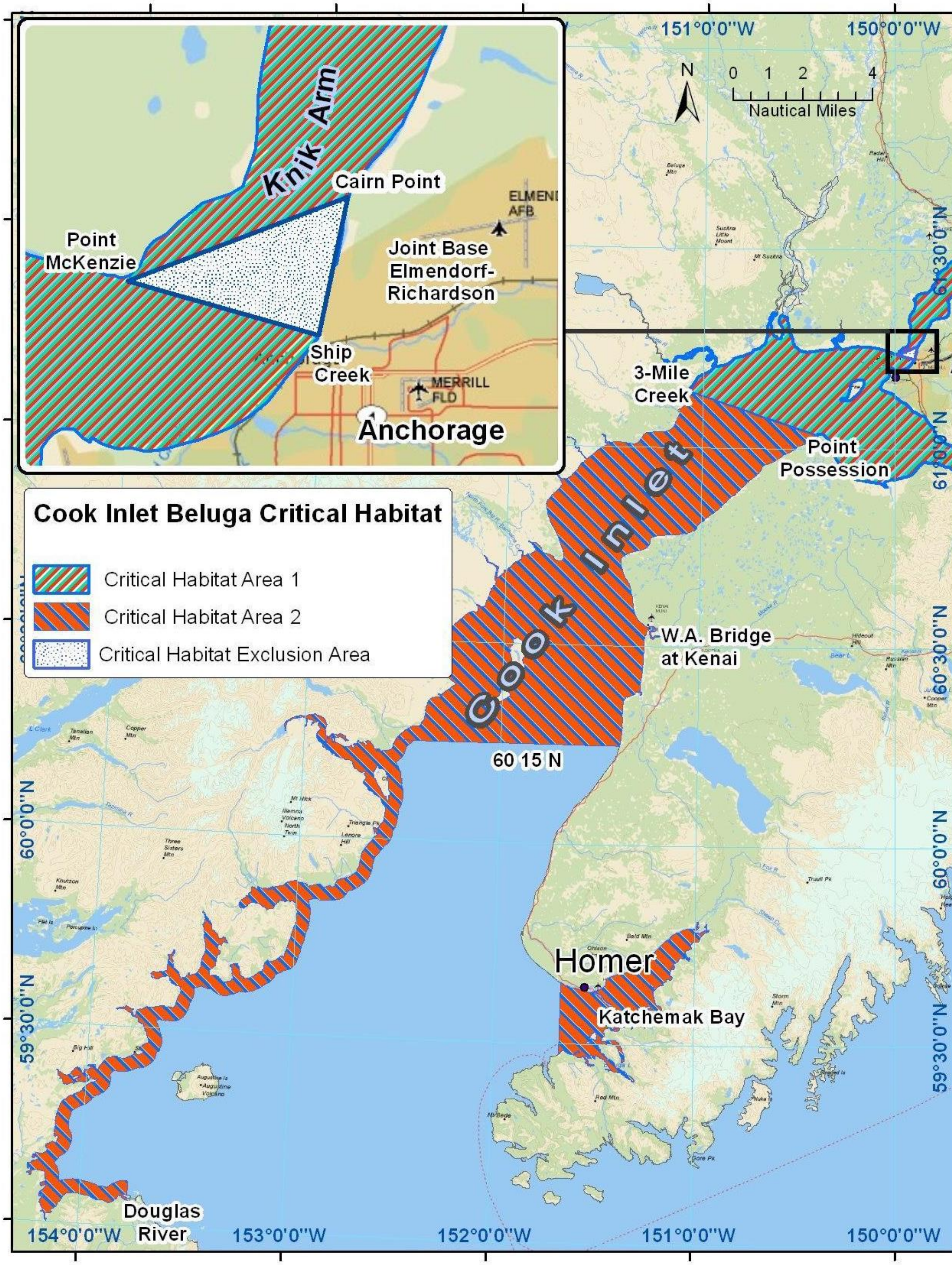

Figure 5. Cook Inlet Beluga Critical Habitat.

Harbor Porpoise (*Phocoena phocoena*)

Harbor porpoise are small (1.5 meters length), relatively inconspicuous toothed whales. The Gulf of Alaska Stock is distributed from Cape Suckling to Unimak Pass and was most recently estimated at 31,046 animals (Allen and Angliss 2014). They are found primarily in coastal waters less than 100 meters (100 meters) deep (Hobbs and Waite 2010) where they feed on Pacific herring (*Clupea pallasii*), other schooling fishes, and cephalopods.

Although they have been frequently observed during aerial surveys in Cook Inlet, most sightings are of single animals, and are concentrated at Chinitna and Tuxedni bays on the west side of lower Cook Inlet (Rugh *et al*. 2005a). Dahlheim *et al*. (2000) estimated the 1991 Cook Inlet-wide population at only 136 animals. However, they are one of the three marine mammals (besides belugas and harbor seals) regularly seen in upper Cook Inlet (Nemeth *et al*. 2007), especially during spring eulachon and summer salmon runs. Because harbor porpoise have been observed throughout Cook Inlet during the summer months, including mid-inlet waters, they represent one species that could be encountered during seismic operations in upper Cook Inlet.

Dall's Porpoise (*Phocoenoides dalli*)

Dall's porpoise are widely distributed throughout the North Pacific Ocean including Alaska, although they are not found in upper Cook Inlet and the shallower waters of the Bering, Chukchi, and Beaufort Seas (Allen and Angliss 2014). Compared to harbor porpoise, Dall's porpoise prefer the deep offshore and shelf slope waters. The Alaskan population has been estimated at 83,400 animals (Allen and Angliss 2014), making it one of the more common cetaceans in the state. Dall's porpoise have been observed in lower Cook Inlet, including Kachemak Bay and near Anchor Point (Owl Ridge 2014), but sightings there are rare. There is a remote chance that Dall's porpoise might be encountered during seismic operations along the Kenai Peninsula.

Killer Whale (*Orcinus orca*)

Two different stocks of killer whales inhabit the Cook Inlet region of Alaska: the Alaska Resident Stock and the Gulf of Alaska, Aleutian Islands, Bering Sea Transient Stock (Allen and Angliss 2014). The resident stock is estimated at 2,347 animals and occurs from Southeast Alaska to the Bering Sea (Allen and Angliss 2014). Resident whales feed exclusively on fish and are genetically distinct from transient whales (Saulitis *et al*. 2000). The transient whales feed primarily on marine mammals (Saulitis *et al*. 2000). The transient population inhabiting the Gulf of Alaska shares mitochondrial DNA haplotypes with whales found along the Aleutian Islands and the Bering Sea suggesting a common stock, although there appears to be some subpopulation genetic structuring occurring to suggest the gene flow between groups is limited (see Allen and Angliss 2014). For the three regions combined, the transient population has been estimated at 587 animals (Allen and Angliss 2014).

Killer whales are occasionally observed in lower Cook Inlet, especially near Homer and Port Graham (Shelden *et al*. 2003, Rugh *et al*. 2005a). A concentration of sightings near Homer and inside Kachemak Bay may represent high use, or high observer-effort given most records are from a whale-watching venture based in Homer. The few whales that have been photographically identified in lower Cook Inlet belong to resident groups more commonly found in nearby Kenai Fjords and Prince William Sound (Shelden *et al*. 2003). Prior to the 1980s, killer whale sightings in upper Cook Inlet were very rare. During aerial surveys conducted between 1993 and 2004, killer whales were observed on only three flights, all in the Kachemak and English Bay area (Rugh *et al*. 2005a). However, anecdotal reports of killer whales feeding on belugas in upper Cook Inlet began increasing in the 1990s, possibly in response to declines in sea lion and harbor seal prey elsewhere (Shelden *et al*. 2003). These sporadic ventures of transient whales into beluga summering grounds have been implicated as a possible contributor to decline of Cook Inlet belugas in the 1990s, although the number of confirmed mortalities from killer whales is small (Shelden *et al*. 2003). If killer whales were to venture into upper Cook Inlet in 2015, they might be encountered during both seismic operations in both upper and lower Cook Inlet.

Steller Sea Lion (*Eumetopia jubatus*)

The Western Stock of the Steller sea lion is defined as all populations west of longitude 144°W to the western end of the Aleutian Islands. The most recent estimate for this stock is 45,649 animals (Allen and Angliss 2014), considerably less than that estimated 140,000 animals in the 1950s (Merrick *et al*. 1987). Because of this dramatic decline, the stock was listed as threatened under ESA in 1990, and was relisted as endangered in 1997. Critical habitat was designated in 1993, and is defined as a 20-nautical-mile radius around all major rookeries and haulout sites (Figure 6).

Steller sea lions inhabit lower Cook Inlet, especially in the vicinity of Shaw Island and Elizabeth Island (Nagahut Rocks) haulout sites (Rugh *et al*. 2005a), but are rarely seen in upper Cook Inlet (Nemeth *et al*. 2007). Of the 42 Steller sea lion groups recorded during Cook Inlet aerial surveys between 1993 and 2004, none were recorded north of Anchor Point and only one in the vicinity of Kachemak Bay (Rugh *et al*. 2005a). Marine mammal observers associated with Buccaneer's drilling project off Cape Starichkof did observe seven Steller sea lions during the summer of 2013 (Owl Ridge 2014).

The 20-nautical-mile buffer was established based on telemetry data that indicated these sea lions concentrated their summer foraging effort within this distance of rookeries and haul outs. The upper reaches of Cook Inlet may not provide adequate foraging conditions for sea lions for establishing a major haul out presence. Steller sea lions feed largely on walleye pollock (*Theragra chalcogramma*), salmon (*Onchorhyncus* spp.), and arrowtooth flounder (*Atheresthes stomias*) during the summer, and walleye pollock and Pacific cod (*Gadus macrocephalus*) during the winter (Sinclair and Zeppelin 2002), none which, except for salmon, are found in abundance in upper Cook Inlet (Nemeth *et al*. 2007). Steller sea lions are unlikely to be encountered during seismic operations in upper Cook Inlet, but they could possibly be encountered along the Kenai Peninsula, especially closer to Anchor Point.

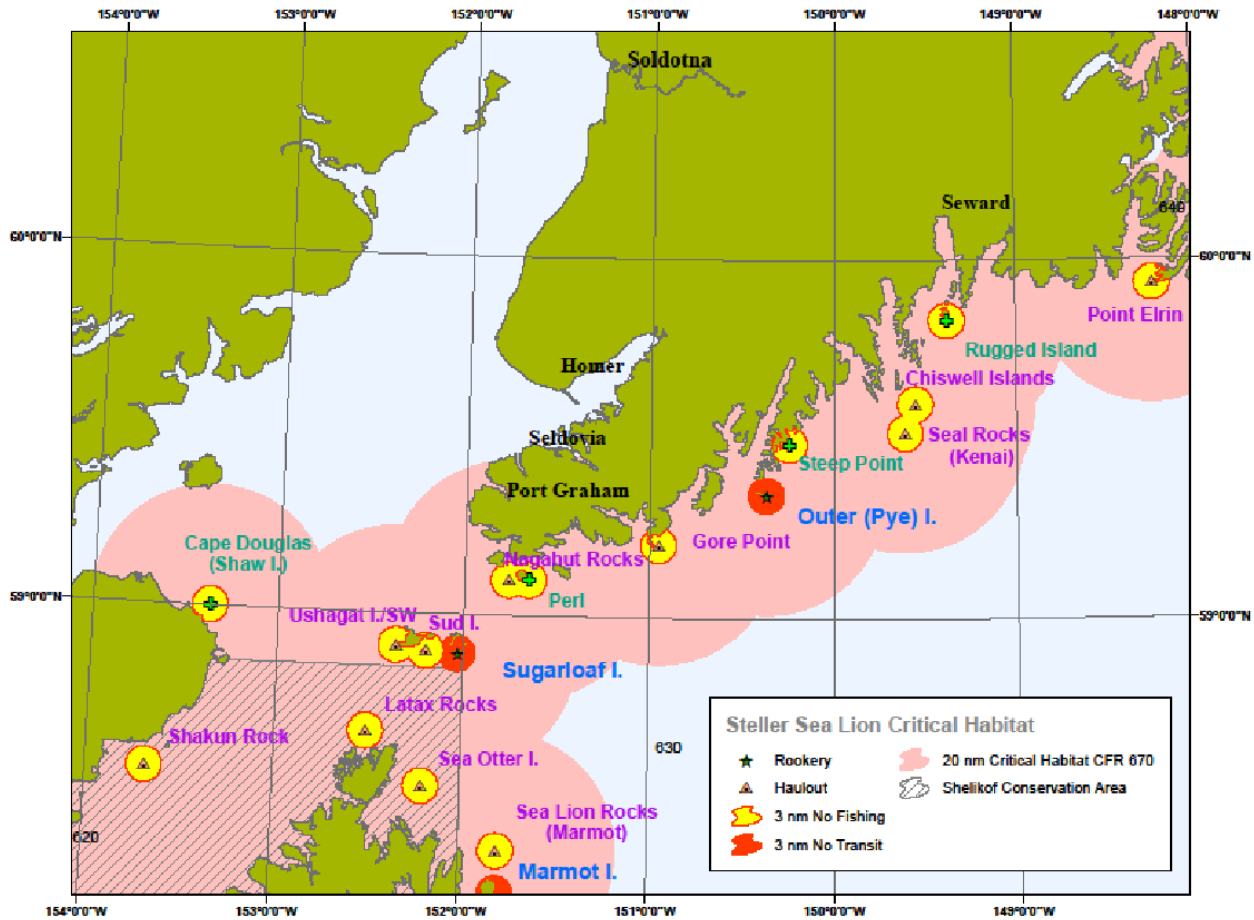

Figure 6. Steller Sea Lion Critical Habitat in the Vicinity of Cook Inlet.

Harbor Seal (*Phoca vitulina*)

With more than 150,000 animals state-wide (Allen and Angliss 2014), harbor seals are one of the more common marine mammal species in Alaskan waters. They are most commonly seen hauled out at tidal flats and rocky areas. Harbor seals feed largely on schooling fish such a walleye pollock, Pacific cod, salmon, Pacific herring, eulachon, and squid. Although harbor seals may make seasonal movements in response to prey, they are resident to Alaska and do not migrate.

The Cook Inlet/Shelikof Stock, ranging from approximately Anchorage down along the south side of the Alaska Peninsula to Unimak Pass, has been recently estimated at a stable 22,900 (Allen and Angliss 2014). Large numbers concentrate at the river mouths and embayments of lower Cook Inlet, including the Fox River mouth in Kachemak Bay (Rugh *et al*. 2005a). Montgomery *et al*. (2007) recorded over 200 haulout sites in lower Cook Inlet alone. However, only a few dozens to a couple hundred seals seasonally occur in upper Cook Inlet (Rugh *et al*. 2005a), mostly at the mouth of the Susitna River where their numbers vary in concert with the spring eulachon and summer salmon runs (Nemeth *et al*. 2007, Boveng *et al*. 2012). In 2012, up to 100 harbor seals were observed hauled out at the mouths of the Theodore and Lewis rivers during monitoring activity associated with SAE's (with Apache) 2012 Cook Inlet seismic program. Montgomery *et al*. (2007) also found seals elsewhere in Cook Inlet to move in response to local steelhead (*Onchorhynchus mykiss*) and salmon runs. Harbor seals may be encountered during seismic operations in both upper and lower Cook Inlet.

5. TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

The incidental take authorization requested is for Level B noise harassment (noise exceeding 160 dB re 1 μPa [rms]) associated with the towed seismic airgun arrays. Actual Level B "takes" will depend upon numbers of marine mammals occurring within the 160 dB ZOI at the time of seismic activity. No Level A injury "takes" (noise exceeding 180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds) are expected with the proposed mitigation measures (see Section 1.3 and Appendix B) in place.

6. TAKE ESTIMATES FOR MARINE MAMMALS

Basis for Estimating Numbers of Marine Mammals That Might Be Exposed

Exposure to impulsive sound levels greater than 160 dB re 1 μPa (rms) can elicit behavioral changes in marine mammals that might be detrimental to health and long-term survival where it disrupts normal behavioral routines, and is the Level B criteria for (impulsive) acoustical harassment under MMPA (NMFS 2005).

Estimated numbers of each species of marine mammals that might be exposed to harassment level noise from OBN seismic arrays was determined by multiplying the maximum area that could be ensonified by greater than 160 dB re 1 μPa (rms) during the season by the average marine mammal densities expressed as number of animals per area surveyed (from NMFS annual aerial surveys 2002 to 2012).

Maximum Ensonified Area

Heath *et al*. (2014) conducted a sound source verification of the very same arrays proposed to be used by SAE in 2015. Their measured distances to the 160 dB for the 440-cubic inch array, the 1,760-cubic-inch array in shallow water, and the 1,760-cubic-inch array in deeper water were 3.05, 4.27, and 6.83 kilometers, respectively (Table 4). Assuming the possibility that all the seismic effort in 2015 could occur in deeper waters, and that no more than 777 square kilometers of area would be surveyed, the maximum ensonified area equates to 777 square kilometers plus a 6.83 kilometer buffer, or 1,732 square kilometers total.

Table 4. Summary of distances to the NMFS thresholds.

Source	Distance to 190 dB Isopleth	Distance to 180 dB Isopleth	Distance to 160 dB Isopleth
440 cubic inch array (very shallow)	50 m	182 m	3.05 km
1,760 cubic inch array (shallow)	830 m	1.53 km	4.27 km
1,760 cubic inch array (deep)	880 m	1.84 km	6.83 km

Marine Mammal Densities

Harbor Porpoise, Killer Whale, Harbor Seal, Steller Sea Lion

Density estimates were calculated for all marine mammals (except beluga whales) by using aerial survey data collected by NMFS in Cook Inlet between 2002 and 2012 (Rugh *et al*. 2002, 2003, 2004a, 2004b, 2005a, 2005b, 2005c, 2006, 2007; Shelden *et al*. 2008, 2009, 2010; Hobbs *et al*. 2011, Shelden *et al*.

2012) and compiled by Apache, Inc. (Apache IHA application 2014). To estimate the annual densities of marine mammals, the total number of animals for each species observed over the 11-year survey period was divided by the total area (65,889 square kilometers) surveyed over the 11 years. The aerial survey marine mammal sightings, survey effort (area), and derived densities are provided in Table 5.

Table 5. Raw density estimates for Cook Inlet marine mammals based on NMFS aerial surveys.

Species	No. of Animals	Area	Mean Raw Density
Harbor Porpoise	249	65,889	0.0038
Killer Whale	42	65,889	0.0006
Harbor Seal	16,117	65,889	0.2446
Steller Sea Lion	599	65,889	0.0091

These raw densities were not corrected for animals missed during the aerial surveys as no accurate correction factors are currently available for these species. However, observer error was limited as the NMFS surveyors often circled marine mammal groups in order to get an accurate count of group size. The harbor seal densities, however, are probably biased upwards given that a large number of the animals recorded were of large groups hauled out at river mouths, and do not represent the distribution in the offshore waters where the seismic activity will actually occur.

Beluga Whale

Exposure estimates for beluga whales are difficult to determine for a seismic project that will confine its activities outside of Critical Habitat Area 1 where beluga would be expected in low densities during the summer. Repeated seismic survey of the same general area can also result in an underestimation or overestimation of potential exposures depending on how it is accounted for in the exposure calculations. Further, beluga often occur in large groups that can confound exposure estimates and result in a single event exceeding a small take authorization. Consequently, with NMFS' guidance, SAE is requesting a maximum take authorization of 30 animals. Should SAE approach 30 beluga takes during the 2015 season, they will either shutdown for the season, or move the operations to an area of much lower beluga density (such as lower Cook Inlet) before the 30 take limit is reached. SAE will consult with NMFS prior to making operational changes to avoid exceeding the take limit.

Other Cook Inlet Marine Mammals

Humpback whales, minke whales, gray whales, and Dall's porpoise have been recorded within lower Cook Inlet and might be encountered during seismic surveys in the lower Cook unit. However, these marine mammals occur in numbers too low to develop density estimates. Thus, take estimates for these species are not empirically derived.

Exposure Calculations

The number of marine mammals that could be exposed to noise levels exceeding 160 dB due to SAE's planned seismic surveys was determined by multiplying the mean raw density for each species by the maximum area that could be ensonified by noise levels exceeding 160 dB (1,732 square kilometers). The results are shown in Table 6.

Table 6. Number of marine mammals potentially exposed to received sound levels >160 dB.

Species	Mean Raw Density	Daily ZOIMaximum Ensonified Area (km^2)	Estimated Exposures

Harbor Porpoise	0.0038	1,732	7
Killer Whale	0.0006	1,732	1
Harbor Seal	0.2446	1,732	424
Steller Sea Lion	0.0091	1,732	16

Take Estimates

Estimated marine mammal exposures in Table 6 do not account for proposed mitigation measures. These measures include shutting down or delaying the start of seismic activities for all marine mammals approaching Level A injury zones and shutting down or delaying start of seismic activities for all ESA listed species (Cook Inlet beluga whale, humpback whale, and Steller sea lion) approaching the Level B harassment zone. Mitigation measures include protocols to "clear" harassment zones before start of activities and ramp-up procedures which will alert local marine mammals of impending loud noise (thereby allowing them to vacate the area before exposure to harassing noise levels). These measures were implemented during SAE's 2012 and 2014 Cook Inlet seismic operations. In 2012, there were *no* Level A or B takes of beluga whales.

Given that these same mitigation procedures to prevent any (Level A or B) takes of beluga whales (see Appendix B, Marine Mammal Monitoring and Mitigation Plan) will be implemented in 2015, *no* Level B takes are expected in 2015. However, it is possible that due to poor observing conditions or a radio communication failure beluga whales might move inside the Level B harassment zone before airguns can be shut- or powered-down. Thus, as a precautionary measure, SAE is requesting a take authorization of up to 30 belugas, a small number representing less than 10 percent of the current population. For the same reason, SAE is requesting take authorization for up to 10 Steller sea lions and 5 humpback whales.

The exposure estimate for harbor seals is probably high because the density estimate is probably high. NMFS repeatedly encountered harbor seals at the mouths of several rivers, which does not accurately reflect the offshore densities where all of SAE's seismic survey would occur during the summer months. During 2012, SAE PSOs detected approximately 200 harbor seals within a much larger harassment zone (due to a larger airgun array) than is estimated for this seismic survey, or only about half of the 424 estimated exposures (without mitigation) calculated for this IHA application. Therefore, based on the previous monitoring, the take request of 424 seals is probably conservative.

For all other species the take authorization request is based on the possibility of encountering a very few of these animals in the lowest reaches of the lower Cook unit (gray whale, Dall's porpoise), or higher than expected (exposure estimate) numbers of encounters based on recent monitoring effort for a drilling program off Cape Starichkof. The requested take authorizations are found in Table 7.

Table 7. Estimated and requested "take" of marine mammals.

Species	Estimated Exposure without Mitigation	Take Authorization Requested
Humpback Whale	-	5
Gray Whale	-	5
Minke Whale	-	10
Beluga Whale	-	30
Killer Whale Alaska (Resident/Transient)	1	5
Dall's Porpoise	-	10
Harbor Porpoise	7	25
Harbor Seal	424	424
Steller Sea Lion	16	25

7. ANTICIPATED IMPACT OF THE ACTIVITY

Introduction

The primary impact of the proposed OBN seismic survey to local marine mammals is acoustical harassment from the 1,760-cubic-inch airgun operations. Noise generated from the airguns could disrupt normal behaviors of marine mammals where received levels exceed 160 dB re 1 μPa. The requested "take" as a percentage of the marine mammal stock is 1.85 percent or less in all cases except for Cook Inlet beluga whales, where the take request is nearly 10 percent (Table 8). However, the requested "take" for beluga whales does not account for mitigation measures can reduce the actual take to zero – based on SAE's 2012 seismic surveys in Cook Inlet.

Table 8. Requested "take" as percentage of the stock.

Species	Abundance	Requested Take	Percent Population
Humpback Whale	7,469	5	0.07%
Gray Whale	19,126	5	0.03%
Minke Whale	1,233	10	0.81%
Beluga Whale	312	30	9.62%
Killer Whale Alaska Resident	2,347	5	0.21%
Killer Whale Alaska Transient	587	5	0.85%
Dall's Porpoise	83,400	10	0.01%
Harbor Porpoise	31,046	25	0.08%
Harbor Seal	22,900	424	1.85%
Steller Sea Lion	45,649	25	0.05%

Abundance sources: Allen and Angliss (2014)

Information related to marine mammal behavioral responses to noise stimuli within the OBN seismic survey area are discussed below. Acoustical injury is possible where received sound levels exceed 180 dB re 1 μPa (cetaceans) or 190 dB re 1 μPa (pinnipeds), but this potential impact will be mitigated by ramping up of airguns and establishing shutdown safety zones (see Section 1.2 and Appendix B).

Behavioral Response

Baleen Whales

Humpbacks, gray whales, and other large baleen whales such as bowhead whales (*Balaena mysticetus*), have shown strong overt reactions to impulsive noises, such as seismic operations, at received levels between 160 and 173 dB re 1 μPa (rms) (Richardson *et al*. 1986; Ljungblad *et al*. 1988; Miller *et al*. 1999, 2005; McCauley *et al*. 2000). However, baleen whales seem to be less tolerant of continuous noise (Richardson and Malme 1993), often detouring around drilling activity when received levels are as low as 119 dB re 1 μPa (rms) (Malme *et al*. 1983, Richardson *et al*. 1985). Based on the previously cited studies, NMFS developed the 120 dB re 1 μPa (rms) harassment criteria for continuous noise sources.

Other than observations that minke whales are often seen at visual ranges from drilling vessels off Greenland (Kapel 1979), there is little information for this species specific to oil and gas related activities. Information on minke reactions to boats is varied. These whales have been observed to avoid boats when approached and approach boats when the boats are stationary (see Richardson *et al*. 1995). Relative to bigger ships, information is lacking.

Ship strikes are not an issue with whales in the ZOI since survey vessels will not exceed 4 to 5 knots. Most strikes of baleen whales occur when vessels are traveling at speeds exceeding 13 knots (http://www.nmfs.noaa.gov/pr/pdfs/shipstrike/ss_speed.pdf). Ship noise due to propeller cavitation can cause behavioral changes by baleen whales. Humpback whales show a general avoidance behavior to cruise ships and tankers at distance from 2 to 4 kilometers (Baker *et al*. 1982, 1983), but no reaction at distances beyond 800 meters when the whales were feeding (Watkins *et al*. 1981, Krieger and Wing 1986). Also, humpback whales are especially responsive to fast moving vessels (Richardson *et al*. 1995) exhibiting aerial behaviors such as breaching or tail/flipper slapping (Jurasz and Jurasz 1979). However, temporarily disturbed whales often remain in the area despite the presence of vessels (Baker *et al*. 1988, 1992).

Beluga Whale

Cook Inlet beluga whales are familiar with, and likely habituated to, the presence of large and small vessels. For example, beluga whales near the Port of Anchorage do not appear to be bothered by the sounds from a passing cargo freight ship (Blackwell and Greene 2002). Beluga whales have displayed avoidance reactions when approached by watercraft, particularly small, fast moving craft that can maneuver quickly and unpredictably. Larger vessels that do not alter course or motor speed around whales seem to cause little, if any, reaction (NMFS 2008). Disturbance from vessel traffic, whether because of the physical presence of the vessels or the noise created by them, could cause short-term behavioral disturbance to beluga whales if they are present, or localized short-term displacement of belugas from their preferred habitats (Richardson 1995).

Researchers have noted behavioral changes in captive beluga whales and other odontocetes when exposed to very loud impulsive sound similar to seismic airguns (Finneran *et al*. 2000, 2002), and field observations in the Beaufort Sea reported evidence of belugas avoiding large array seismic operations (Miller *et al*. 2005). Further, Romano *et al*. (2004) exposed a captive beluga whales to airgun noise levels and found that the whale produced stress-level hormones with increasing sound pressure levels, and some hormone levels remained high as long as an hour after exposure (but these hormone levels were far less than those produced during beluga whale chase and capture events). Although the above observations occurred during beluga exposure to sound pressure levels above those that would be produced by the smaller airgun arrays proposed to be used by SAE, they do demonstrate that beluga are susceptible to noise-induced stress and may avoid high noise levels as result, leading to limited use of the available habitat.

Harbor Porpoise

Harbor porpoise are naturally shy and tend to move away from boats and ships. Reaction to boats can be strong when within 400 meters (Polacheck and Thorpe 1990) out to 1.5 kilometers (Barlow 1988). There is little information on harbor porpoise reaction to seismic activities, but they probably show tolerance to noise levels similar to other odontocetes given their effective hearing is above frequencies characterizing airgun sounds. However, Lucke *et al*. (2009) recently exposed harbor porpoise and found that a temporary threshold shift (TTS) was induced at sound pressure levels of about 200 dB re 1 μPa (peak-peak) and harbor porpoises showed behavioral aversion to impulsive sounds as low as 174 dB re 1 μPa (peak-peak), indicating a greater sensitivity to impulsive noise than beluga whales. Acoustical harassment devices with full spectrum impulsive source levels of 180 dB re 1 μPa effectively deterred harbor porpoise from salmon pens (Johnston 2002).

Dall's Porpoise

Dall's porpoise are known to have an affinity for bow-riding both large and small vessels (Jefferson *et al*. 2010). There is little information on how Dall's porpoise react to seismic vessels. However, given the lack of sensitivity of other odontocetes to low frequency vessel noise and their propensity to bow-ride it is not anticipated they will avoid the seismic vessels if encountered.

Killer Whale

There is very little information on killer whale reactions to seismic activity or boats other than studies on tour boat impacts to inland stocks of Washington and British Columbia. As odontocetes, killer whales are probably less sensitive to low frequency vessel noises. However, killer whales are sensitive to impulsive noises as evidenced by the effective use of acoustical harassment devices to protect salmon pen fisheries (Morton and Symonds 2002).

Seals and Sea Lions

Pinnipeds in general appear somewhat tolerant of underwater industrial noises, partially because they can escape underwater pressure levels by exposing their head above the water surface, and they are less sensitive to lower frequency noises. In her review of the known effects of noise on marine mammals, Weilgart (2007) largely confined her discussion on cetaceans and only once mentioned a possible negative effect on pinnipeds. Richardson *et al*. (1995) were not aware of any detailed data on reactions of seals to seismic noise, and expected them to tolerate or habituate to underwater seismic noise, especially if food sources were present. However, ringed seal avoidance of large seismic airgun arrays has been noted during monitoring studies in the Beaufort Sea (Moulton and Lawson 2002, Miller *et al*. 2005).

Most information on the reaction of seals and sea lions to boats relate to disturbance of hauled out animals. There is little information on the reaction of these pinnipeds to ships while in the water other than some anecdotal information that sea lions are often attracted to boats (Richardson *et al*. 1995).

Temporary Threshold Shift and Permanent Threshold Shift

Noise has the potential to induce temporary TTS or permanent (permanent threshold shift [PTS]) hearing loss (Weilgart 2007). The level of loss is dependent on sound frequency, intensity, and duration. Similar to masking, hearing loss reduces the ability for marine mammals to forage efficiently, maintain social cohesion, and avoid predators (Weilgart 2007). For example, Todd *et al*. (1996) found an unusual increase in fatal fishing gear entanglement of humpback whales to coincide with blasting activities, suggesting hearing damage from the blasting may have compromised the ability for the whales to use sound to passively detect the nets. Experiments with captive bottlenose dolphins and beluga whales found that short duration impulsive sounds can cause TTS (Finneran *et al*. 2002). Southall *et al*. (2007) recommended 224 dB re 1 μPa (peak) as the behavioral disturbance criteria for mid-frequency cetaceans such as beluga based on Finneran *et al*.'s (2002) study results suggesting that his is the threshold for TTS onset for belugas.

In general, pinnipeds are tolerant of high noise levels (Richardson *et al*. 1995), and have the ability to escape underwater noises for short periods by keeping their head above water. Sound exposures that elicit TTS have been studied in harbor seals and sea lions (Southall *et al*. 2007). Studies on non-impulsive noise exposures have shown that harbor seals are likely to experience TTS at lower exposure levels than sea lions (Kastak *et al*. 1999, 2005). Harbor seals experienced TTS at 25-minute exposure to sound pressure levels as low as 153 dB re 1 μPa. Only one study (Finneran *et al*. 2003) has measured pinniped TTS-onset from impulsive noises, and found no measurable TTS in California sea lions following exposures up to 183 dB re 1 μPa (peak-peak).

PTS occurs when continuous noise exposure causes hairs within the inner ear system to die. This can occur due to moderate durations of very loud noise levels, or long-term continuous exposure of moderate noise levels. However, PTS is not an issue with impulsive seismic noise, and continuous noise from the cavitation of boat propellers are of short term for a given location since the vessels are either constantly moving, or idle and not producing noise.

Masking

Masking occurs when louder airgun noises interfere with marine mammal vocalizations or ability to hear natural sounds in their environment (Richardson *et al*. 1995), which limit their ability to communicate or avoid predation or other natural hazards. Masking is of special concern for baleen whales that vocalize at low frequencies over long distances, as their communication frequencies overlap with anthropogenic noises such as shipping traffic and seismic airgun frequencies. Some baleen whales have adjusted their communication frequencies, intensity, and call rate to limit masking effects. For example, McDonald *et al*. (2009) found that California blue whales (*Balaenoptera musculus*) have shifted their call frequencies downward by 31 percent since the 1960s, possibly in an attempt to communicate below shipping noise frequencies. Melcon *et al*. (2012) found blue whales to increase their call rates in the presence of shipping noise, but to significantly decrease call rates when exposed to mid-frequency sonar. Also, Di Iorio and Clark (2010) found blue whales to communicate more often in the presence of seismic surveys, which they attributed to compensating for an increase in ambient noise levels. Fin whales (*Balaenoptera physalus*) have reduced their calling rate in response to boat noise (Watkins 1986), and were thought to stop singing altogether for weeks in response to seismic surveys (International Whaling Commission 2007).

Odontocetes hear and communicate at frequencies well above the less than 1 kHz frequency of a seismic shot (Wartzok and Ketten 1999). Beluga whales have a well-developed and well-documented sense of hearing. White *et al*. (1978) measured the hearing of two belugas whales and described hearing sensitivity between 1 kHz and 130 kHz, with best hearing between 30 kHz to 50 kHz. Awbrey *et al*. (1988) examined their hearing in octave steps between 125 Hz and 8 kHz, with average hearing thresholds of 121 dB re1 μPa at 125 Hz and 65 dB re 1 μPa at 8 kHz. Johnson *et al*. (1989) further examined beluga hearing at low frequencies, establishing that the beluga whale hearing threshold at 40 Hz was 140 dB re 1 μPa. Ridgway *et al.* (2001) measured hearing thresholds at various depths down to 300 meters (984 feet) at frequencies between 500 Hz and 100 kHz. Beluga whales showed unchanged hearing sensitivity at this depth. Lastly, Finneran *et al*. (2005) measured the hearing of two belugas, describing their auditory thresholds between 2 kHz and 130 kHz. In summary, these studies indicate that beluga whales hear from approximately 40 Hz to 130 kHz, with maximum sensitivity from approximately 30 kHz to 50 kHz. It is important to note that these audiograms represent the best hearing of belugas, measured in very quiet conditions. These quiet conditions are rarely present in the wild, where high levels of ambient noise may exist.

It is expected that while odontocetes such as beluga whales and harbor porpoise will be able to detect the planned seismic pulses, it is unclear whether or not they would mask the ability of these high-frequency animals to communicate.

Stress and Mortality

Safety zones will be established to prevent acoustical injury to local marine mammals, especially injury that could indirectly lead to mortality. Also, seismic noise is not expected to cause resonate effects to gas-filled spaces or airspaces in marine mammals based on the research of Finneran (2003) on beluga whales showing that the tissue and other body masses dampen any potential effects of resonance on ear cavities, lungs, and intestines. However, chronic exposure to seismic noise could lead to physiological stress eventually causing hormonal imbalances (NRC 2005). If survival demands are already high, and/or additional stressors are present, the ability of the animal to cope decreases leading to pathological conditions or death (NRC 2005). Affects may be greatest where noise disturbance can disrupt feeding patterns including displacement from critical feeding grounds.

However, monitoring hormonal levels in free-ranging marine mammals is difficult if not nearly impossible, and most evidence is by extension from studies on terrestrial species or from studies on marine mammals where stress could not be isolated as the primary pathological causation (NRC 2003).

Romano *et al*. (2004) did, however, expose a captive beluga whale to typical seismic airgun noises (226 dB re 1 μPa), and found that the whale produced stress-level hormones with increasing sound pressure levels, and some hormone levels remained high as long as an hour after exposure. Although SAE's seismic activities will operate for extended periods of time, this activity will be limited to areas south of the Beluga River during the summer period when belugas, harbor seals, and harbor porpoises are concentrated in important feeding and breeding nearshore waters at the Susitna Delta. Chronic exposure to elevated seismic noise is not expected.

8. ANTICIPATED IMPACTS ON SUBSISTENCE USES

The proposed seismic activities will occur near the marine subsistence area used by the villages of Tyonek, Ninilchik, Anchor Point, and Kenai. The only marine mammal regularly harvested by these villages is the harbor seal (Wolfe *et al*. 2009). Based on subsistence harvest data collected by the Alaska Department of Fish and Game (Wolfe *et al*. 2009) between 1992 and 2008 (the last year of published results), Kenai hunters harvested an average of about 13 harbor seals per year, while Tyonek hunters only about 1 seal per year (Ninilchik and Anchor Point were not included in the survey). Traditionally, Tyonek hunters harvested seals at the Susitna River mouth, or incidental to salmon netting or during boat-based moose hunting trips (Fall *et al*. 1984). Although Steller sea lions are listed under the ESA, they can still be harvested by Alaskan natives for subsistence harvest. Steller sea lions are rare in mid and upper Cook Inlet, which is reflected in the subsistence harvest data. Between 1992 and 2008, only two sea lions were reported harvested by Kenai hunters and none by Tyonek hunters (Wolfe *et al*. 2008). Sea lions are more commonly harvested by villages south of the proposed seismic activity areas, such as Seldovia, Port Graham, and Nanwalek (Merrill and Opheim 2013).

A series of moratoriums were placed on Cook Inlet beluga subsistence harvest beginning 1999, following severe harvest pressure in the mid-1990s that saw annual removals of 10 to 15 percent of the population (Mahoney and Shelden 2000) resulting in a population decline from an estimated 1,300 whales in 1979 (Calkins 1989) to a recent estimate of 312 animals (Allen and Angliss 2014). Although only five whales have been harvested since 1999 (Hobbs *et al*. 2008, Allen and Angliss 2014), the population has continued to decline. No future subsistence harvest is planned until after the 5-year population average has grown to at least 350 whales.

Although the hunters from the village of Tyonek are recognized for their traditional subsistence harvest of beluga whales, these subsistence hunters were not involved with the high harvest activity in the 1990s, and their harvest numbers remained low (Stephen R. Braund & Associates and Huntington Consulting [SRBA and HC] 2011). Village harvest between 1980 and 2000 has generally averaged less than one beluga (Fall *et al*. 1984, SRBA and HC 2011).

SAE's planned seismic exploration activities will not impact the availability of harbor seals or Steller sea lions for subsistence harvest in Cook Inlet. Harbor seals are generally harvested at nearshore areas where seismic operations are less likely to occur, and Steller sea lion numbers are not an important subsistence resource in the project areas due to naturally low numbers. The impact of seismic operations is unlikely to affect either harbor seal or sea lion populations sufficient to render them unavailable for subsistence harvest in the future. Beluga subsistence harvest is currently under moratorium. Based on the most recent population estimates, no beluga harvest will be authorized in 2015 when SAE's seismic activities would occur.

Prior to conducting seismic surveys in any waters deemed of subsistence importance to a given local village, SAE will meet and consult with representatives of local villages and native corporations. SAE's Plan of Cooperation, designed to avoid conflicts with subsistence use, is attached as Appendix C.

9. ANTICIPATED IMPACTS ON HABITAT

The OBN seismic survey area could occur within both upper and lower Cook Inlet. Cook Inlet is a large subarctic estuary roughly 300 kilometers (186 miles) in length and averaging 96 kilometers (60 miles) in width. It extends from the city of Anchorage at its northern end and flows into the Gulf of Alaska at its southernmost. For descriptive purposes, Cook Inlet is separated into unique upper and lower sections, divided at the East and West Forelands, where the opposing peninsulas create a natural waistline in the length of the waterway, measuring approximately 16 kilometers (10 miles) across (Mulherin *et al*. 2001).

Upper Cook Inlet comprises the area between Point Campbell (Anchorage) down to the Forelands, and is roughly 95 kilometers (59 miles) in length and 25 kilometers (15.5 miles) in width (Mulherin *et al*. 2001). Five major rivers (Knik, Matanuska, Susitna, Little Susitna, and Beluga) deliver freshwater to upper Cook Inlet, carrying a heavy annual sediment load of over 40 million tons of eroded materials and glacial silt (Brabets 1999). As a result, upper Cook Inlet is relatively shallow, averaging 18.3 meters (60 feet) in depth. It is characterized by shoals, mudflats, and a wide coastal shelf, less than 18 meters (59 feet) deep, extending from the eastern shore. A deep trough exists between Trading Bay and the Middle Ground Shoal, ranging from 64 to 140 meters (114 to 253 feet) deep (NOAA Nautical Chart 16660). The substrate consists of a mixture of coarse gravels, cobbles, pebbles, sand, clay, and silt (Bouma *et al*. 1978, Rappeport 1982).

Upper Cook Inlet experiences some of the most extreme tides in the world, demonstrated by a mean tidal range from 4 meters (13 feet) at the Gulf of Alaska end to 8.8 meters (29 feet) near Anchorage (U.S. Army Corps of Engineers [USACE] 2013). Tidal currents reach 2 meters per second (3.9 knots) (Mulherin *et al*. 2001) in upper Cook Inlet, increasing to 3 to 4 meters per second (5.7 to 7.7 knots) near the Forelands where the inlet is constricted. Each tidal cycle creates significant turbulence and vertical mixing of the water column in the upper inlet (USACE 2013), and are reversing, meaning that they are marked by a period of slack tide followed an acceleration in the opposite direction (Mulherin *et al*. 2001).

Because of scouring, mixing, and sediment transport from these currents, the marine invertebrate community is very limited (Pentec 2005). Of the 50 stations sampled by Saupe *et al*. 2005 for marine invertebrates in Southcentral Alaska, their upper Cook Inlet station had by far the lowest abundance and diversity. Further, the fish community of upper Cook Inlet is characterized largely by migratory fish – eulachon and Pacific salmon – returning to spawning rivers, or outmigrating salmon smolts. Moulton (1997) documented only 18 fish species in upper Cook Inlet compared to at least 50 species in found lower Cook Inlet (Robards *et al*. 1999)

Lower Cook Inlet extends from the Forelands southwest to the inlet mouth demarked by an approximate line between Cape Douglas and English Bay. Water circulation in lower Cook Inlet is dominated by the Alaska Coastal Current (ACC) that flows northward along the shores of the Kenai Peninsula until it is turned westward and mixed by the combined influences of freshwater input from upper Cook Inlet, wind, topography, tidal surges, and the coriolis effect (Field and Walker 2003, Minerals Management Service 1996). Upwelling by the ACC brings nutrient-rich waters to lower Cook Inlet and contributes to a biologically rich and productive ecology (Sambrotto and Lorenzen 1986). Tidal currents average 1.0 to 1.5 meters per second (2 to 3 knots) and are rotary in that they do not completely go slack before rotating around into an opposite direction (Gatto 1976, Mulherin *et al*. 2001). Depths in the central portion of lower Cook Inlet are 60 to 80 meters (197 to 262 feet) and decrease steadily toward the shores (Muench 1981). Bottom sediments in the lower inlet are coarse gravel and sand that grade to finer sand and mud toward the south (Bouma 1978).

Coarser substrate support a wide variety of invertebrates and fish including Pacific halibut (Hippoglossus stenolepis), Dungeness crab (*Metacarcinus magister*), tanner crab (*Chionoecetes bairdi*), pandalid shrimp (*Pandalus* spp.), Pacific cod, and rock sole (*Lepidopsetta bilineata*), while the soft-bottom sand and silt communities are dominated by polychaetes, bivalves and other flatfish (Field and Walker 2003). Sea urchins (*Strongylocentrotus* spp.) and sea cucumbers (Parastichopus californicus) are important otter prey and are found in shell debris communities. Razor clams (*Siliqua patula*) are found all along the beaches of the Kenai Peninsula. In general, the lower Cook Inlet marine invertebrate community is of low abundance, dominated by polychaetes, until reaching the mouth of the inlet (Saupe *et al*. 2005). Overall, the lower Cook Inlet marine ecosystem is fed by midwater communities of phytoplankton and zooplankton, with the latter composed mostly of copepods, and barnacle and crab larvae (Damkaer 1977, English 1980).

Project activities that could potentially impact marine mammal habitats include laying nodes on the sea bottom and acoustical injury of prey resources. However, there are few benthic resources in the survey area that could be impacted by the temporary placement of rope-tethered nodes (Saupe *et al*. 2005). The primary affect might be temporary displacement of mobile benthic resources such as crabs.

Acoustical affects to prey resources are also limited. Christian *et al*. (2004) studied seismic energy impacts on male snow crabs (*Chionoecetes* sp.) and found no significant increases in physiological stress due to exposure. No acoustical impact studies have been conducted to date on the above fish species, but studies have been conducted on Atlantic cod (*Gadus morhua*) and sardine (*Clupea* sp). Davis *et al*. (1998) cited various studies found no effects to Atlantic cod eggs, larvae, and fry when received levels were 222 dB. What effects were found were to larval fish within about 5 meters, and from airguns with volumes between 3,000 and 4,000 cubic inches. Similarly, effects to sardine were greatest on eggs and 2-day larvae, but these effects were greatest at 0.5 meters, and again confined to 5 meters. Further, Greenlaw *et al*. (1988) found no evidence of gross histological damage to eggs and larvae of northern anchovy (*Engraulis mordax*) exposed to seismic airguns, and concluded that noticeable effects would result only from multiple, close exposures. Based on these results, the 1,760-cubic-inch airguns planned for the Cook Inlet seismic survey could damage larval fish, but only out to about 2 or 3 meters at most. From an ecological community standpoint, these impacts are considered minor.

Overall, laying of nodes and acoustical effects on prey resources will have a minor effect at most on the marine mammal habitat within the seismic survey area. Some prey resources might be temporarily displaced, but no long-term effects are unexpected.

10. ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

Based on the conclusions of Section 9 above, no loss or direct modification of marine mammal habitat is expected. Any impacts to prey resources is considered minor or negligible, and no long-term effects would occur. The acoustic environment created by the seismic activity could, however, result in habitat displacement for any marine mammal that chose to avoid the higher noise levels. The maximum area that could be ensonified in a given day of seismic activity is the maximum daily shoot area with a 6.83-kilometer buffer, or 344 square kilometers. This area represents about 1.6 percent of the 20,943 square kilometer Cook Inlet, and would not include the Susitna Delta region where belugas, harbor porpoise, and harbor seals concentrate in the summer to feed on fish runs. Thus, while the seismic activity will likely result in some level of habitat displacement, it is probably negligible given the habitat available and the summer distribution of local marine mammals.

11. MITIGATION MEASURES

The primary means of minimizing potential impacts to marine mammals include: 1) using a relative small maximum seismic array (1,760 cubic inches) with sound sources much less than typical 3D seismic arrays; 2) establishing shutdown safety zones to ensure marine mammals are not injured by noise levels exceeding Level A injury thresholds; 3) ramping up (initially firing seismic guns at low power), thereby alerting marine mammals of impending seismic noise and allowing them to vacate the general area before they become exposed to harassing sound levels; and 4) timing survey activity to seasonally avoid concentrations of beluga whales (upper Cook) and baleen whales (lower Cook). Reducing and mitigating potential acoustical impacts to local marine mammals during seismic activity is fully addressed in the Marine Mammal Monitoring and Mitigation Plan attached as Appendix B.

12. ARTIC PLAN OF COOPERATION

All of the upper Cook unit and a portion of the lower Cook unit falls north of 60°N, or within the region NMFS has designated as an Arctic subsistence use area. As mentioned in Section 8, there are several villages in SAE's proposed project area that have traditionally hunted marine mammals, primarily harbor seals. Tyonek is the only tribal village in upper Cook Inlet with a tradition of hunting marine mammals, in this case harbor seals and beluga whales. However, for either species the annual recorded harvest since the 1980s has averaged about one or fewer of either species (Fall *et al*. 1984, Wolfe *et al*. 2009, SRBA and HC 2011), and there is currently a moratorium on subsistence harvest of belugas. Further, many of the seals that are harvested are done incidentally to salmon fishing or moose hunting (Fall *et al*. 1984, Merrill and Orpheim 2013), often near the mouths of the Susitna Delta rivers (Fall *et al*. 1984) north of SAE's proposed seismic survey area.

Villages in lower Cook Inlet adjacent to SAE's proposed seismic area (Kenai, Salamatof, and Ninilchik) have either not traditionally hunted beluga whales, or at least not in recent years, and rarely do they harvest sea lions. Between 1992 and 2008, the only reported sea lion harvests from this area were two Steller sea lions taken by hunters from Kenai (Wolfe *et al*. 2009). These villages more commonly harvest harbor seals, with Kenai reporting an average of about 13 per year between 1992 and 2008 (Wolfe *et al*. 2008). According to Fall *et al*. (1984), many of the seals harvested by hunters from these villages were taken on the west side of the inlet during hunting excursions for moose and black bears (or outside SAE's lower Cook unit).

Although marine mammals remain an important subsistence resource in Cook Inlet, the number of animals annually harvested are low, and are primarily harbor seals. Much of the harbor seal harvest occurs incidental to other fishing and hunting activities, and at areas outside of the SAE's proposed seismic areas such as the Susitna Delta or the west side of lower Cook Inlet. Also, SAE is unlikely to conduct seismic activity in the vicinity of any of the river mouths where large numbers of seals haul out. Thus, SAE will not affect local populations of harbor seals or sea lions such that they would be unavailable for subsistence harvest in 2015.

13. MONITORING AND REPORTING

Monitoring and reporting potential acoustical impacts to local marine mammals are fully addressed in the Marine Mammal Monitoring and Mitigation Plan attached as Appendix B.

14. SUGGESTED MEANS OF COORDINATION

Potential impacts of seismic noise on marine mammals have been studied, with the results used to establish the noise criteria for evaluating "take" and to support shutting down seismic operations to avoid Level A injury "take". However, all observations of marine mammals, including any observed reactions to the seismic operations will be recorded and reported to NMFS.

Further, to ensure that there will be no adverse effects resulting from the planned seismic exploration, SAE is coordinating with NMFS, USFWS, Bureau of Safety and Environmental Enforcement, the USACE, the State of Alaska, and other state and federal agencies in the assessment of all measures that can be taken to eliminate or minimize any impacts from planned activities. SAE has also reached out and coordinated to numerous communities including the cities and villages of Kenai, Tyonek, and Ninilchik, as well as Kenai Peninsula Borough, Cook Inlet Region, Inc., Cook Inlet Keeper, United Cook Inlet Drift Association, and GCI telecommunications.

Any observed marine mammal interactions with the SAE operations deemed potentially harmful will be immediately reported to the Anchorage Office of NMFS. Given the very low likelihood of observing cetaceans and pinnipeds during the Cook Inlet operations, especially considering the actions (such as timing) to be taken to avoid encounters, developing a research program would be impractical.

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APPENDIX A

The 1,760 and 440 cui Array Configurations, Far-field Signatures, and Directivity Plots

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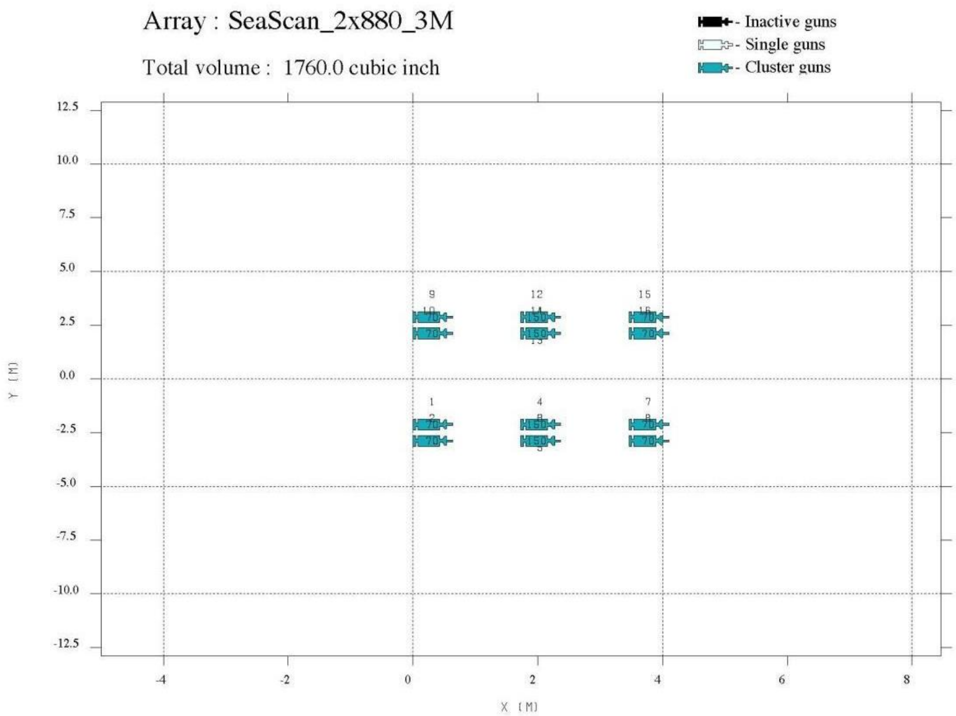
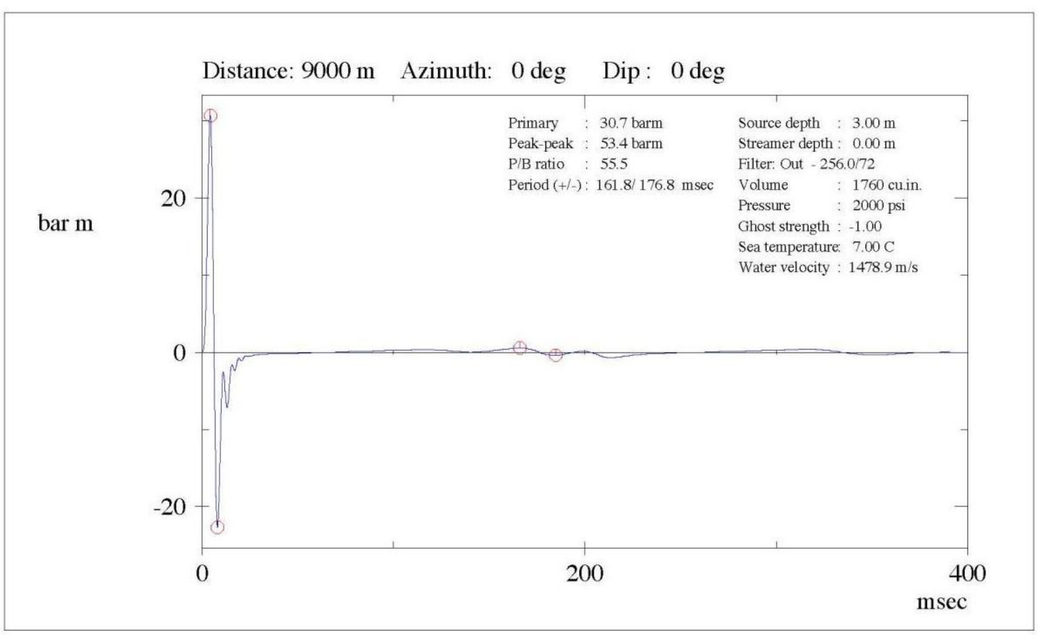
Note on Directivity Plots: The manufacturer-provided directivity plots below illustrate how the airgun acoustical energy, measured in decibels, is focused downward to maximum the reflective return of the acoustical signal. Between 0 and 150 Hertz, there is little immediate loss in energy within a 120 degree arc centered straight down. However, for regions of the water column nearest the surface, the received energy relative to source is 30 to 60 decibels less. These plots do not provide a measure of how energy dissipates over time and distance, but rather illustrates that the airgun energy is not omni-directional, but rather focused vertically. Received sound levels horizontal of the source are much less than levels vertical of (immediately below) the source.

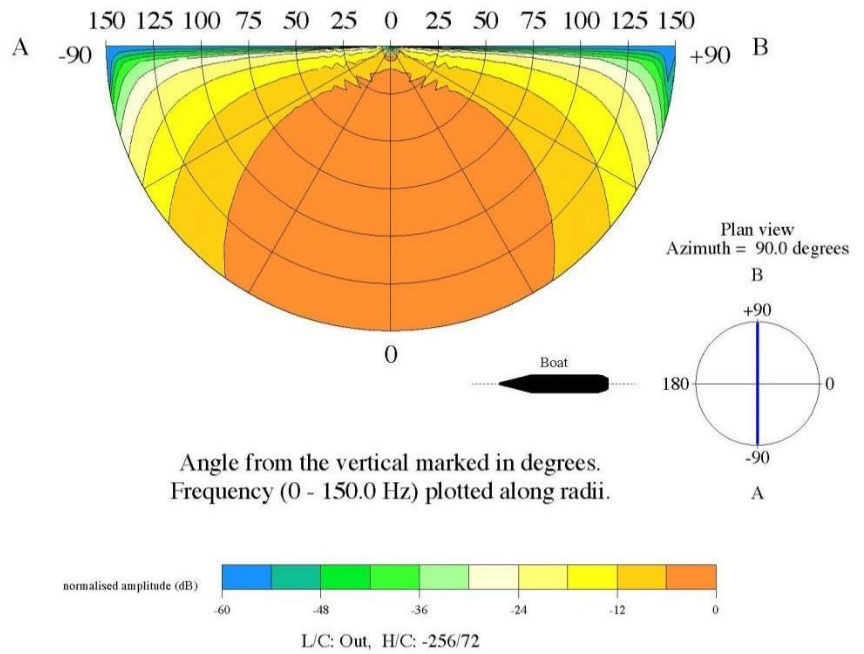


Farfield signature : SeaScan_2x880_3M

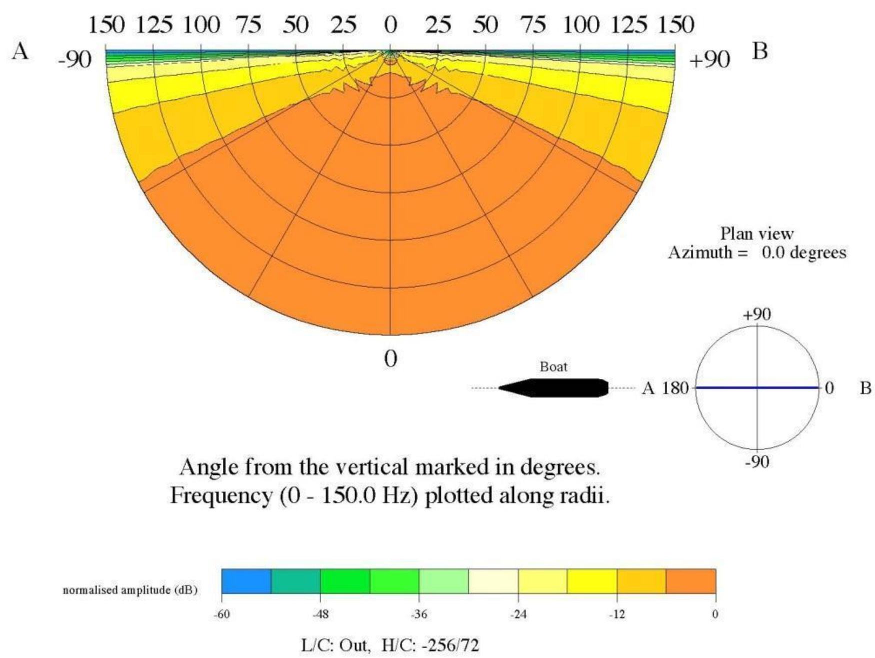


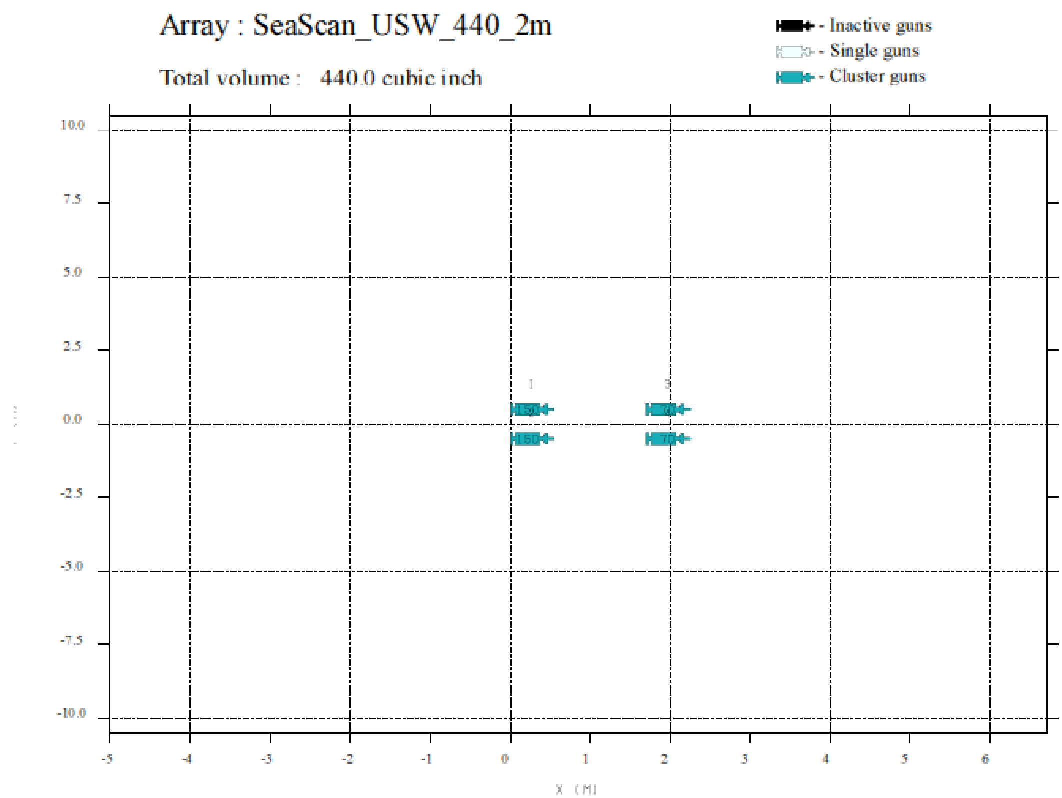
L/C: Out, H/C: -256/72

Source Directivity Plot - azimuth : 90.0 degrees - array SeaScan_2x880_3M

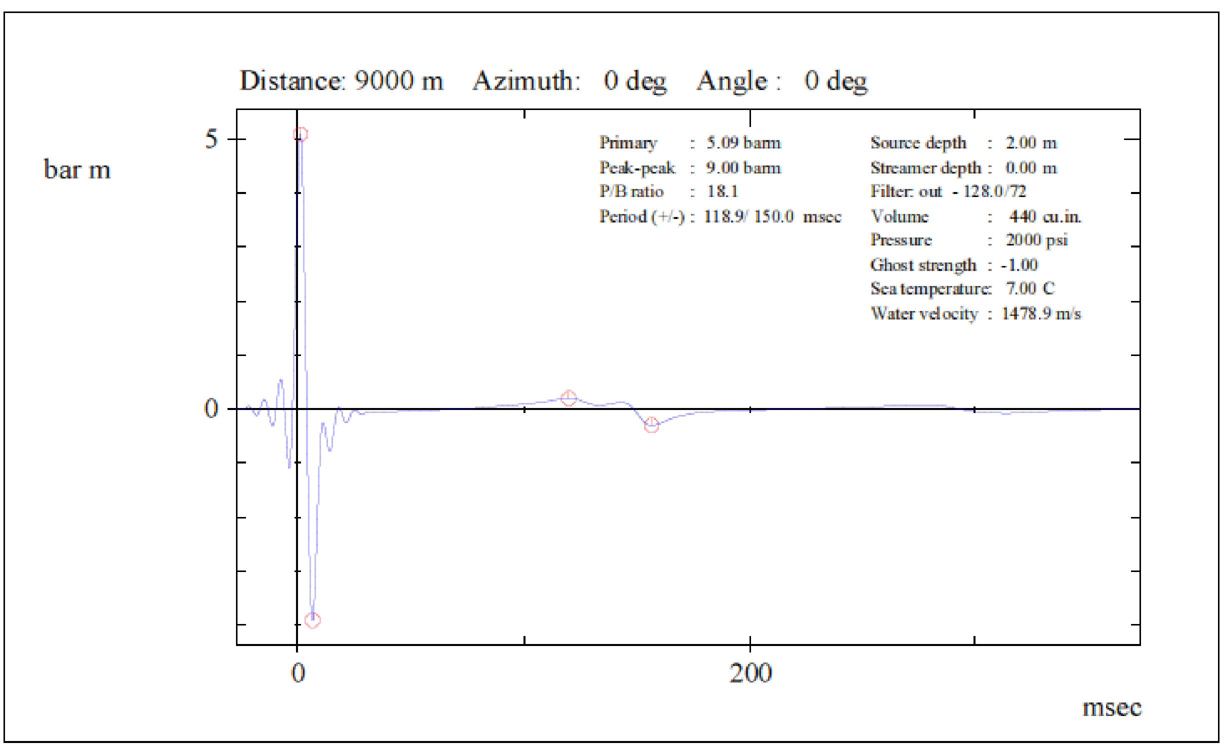


Source Directivity Plot - azimuth : 0.0 degrees - array SeaScan_2x880_3M

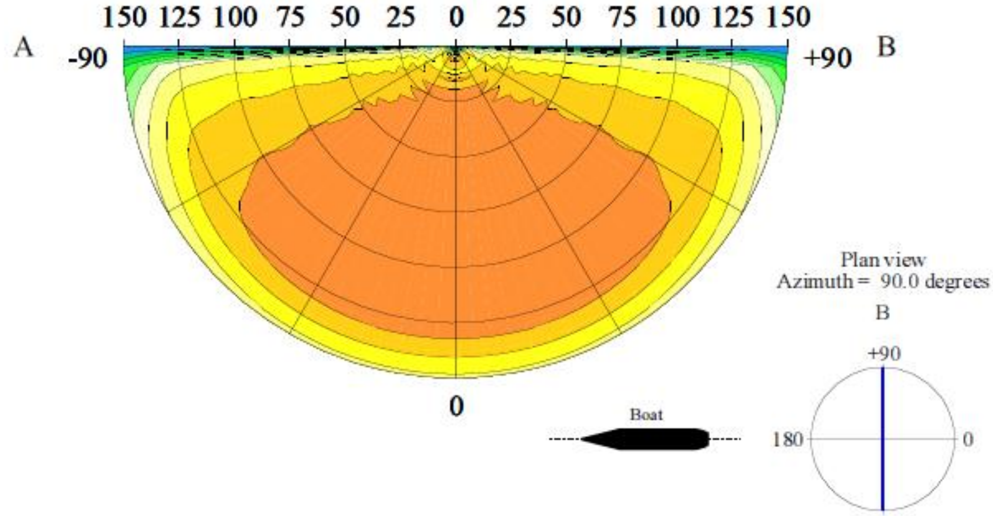




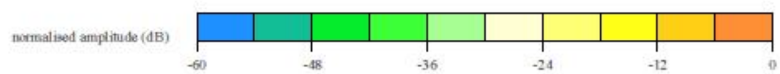
Far-field signature of array : SeaScan_USW_440_2m



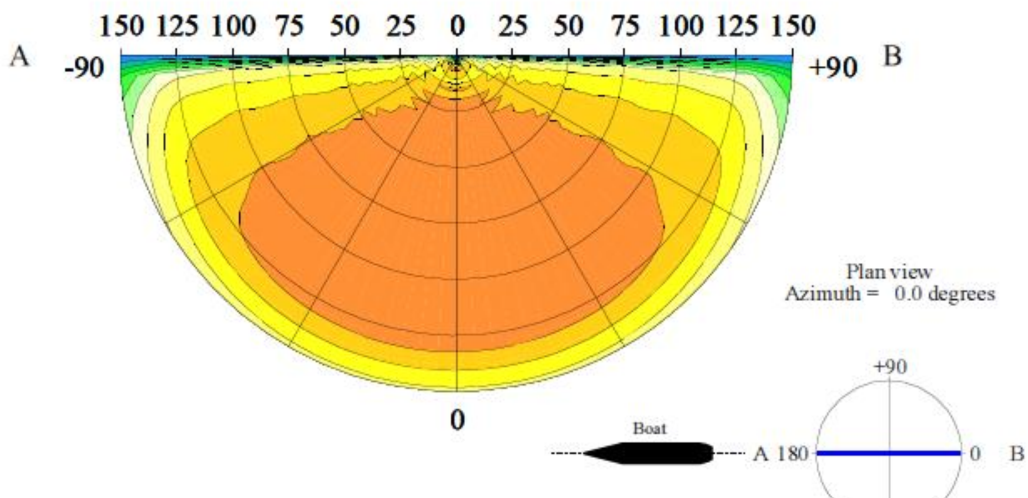
Source Directivity Plot - azimuth : 90.0 degrees - array SeaScan_USW_440_2m



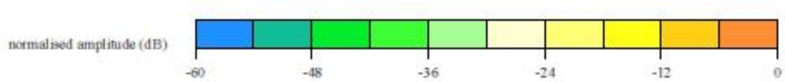
Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.



Source Directivity Plot - azimuth : 0.0 degrees - array SeaScan_USW_440_2m



Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.



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APPENDIX B

Marine Mammal Monitoring and Mitigation Plan

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Marine Mammal Monitoring and Mitigation Plan

SAE Cook Inlet 3D Seismic Survey Operations - 2015

1. INTRODUCTION

The SAExploration (SAE) marine mammal monitoring and mitigation plan (4MP) for proposed Cook Inlet seismic exploration surveys is described below. SAE understands that the 4MP will be subject to review by NMFS and that refinements may be required in the 4MP to meet requirements established in the Incidental Harassment Authorization (IHA). To avoid any takes by injury (Level A), SAE will employ NMFS-approved Protected Species Observers (PSOs) to implement mitigation measures and monitor all seismic activities for IHA compliance. PSOs will be positioned on seismic and dedicated mitigation vessels for monitoring marine mammals to provide early warning of approaching marine mammals and to monitoring the 160 dB harassment zone.

2. PROPOSED SAFETY AND HARASSMENT MONITORING RADII

The IHA issued by NMFS will establish harassment and safety zones appropriate for cetaceans and pinnipeds in reference to Zones of Influence (ZOI) surrounding the airgun array on the source vessel where the PSOs will be tasked with monitoring ZOIs relative to received level of 180 dB and 190 dB. Harassment zones for cetaceans are based on the estimated area of ensonification relative to the sound source.

Preliminary monitoring zones for the 190, 180, and 160 dB with the various airgun configurations were estimated. These estimates are provided in Table 1. SAE PSOs will monitor these zones for marine mammals before, during, and after the operation of the airguns. Monitoring will be conducted using qualified PSOs on vessels. Preliminary monitoring zones will be adjusted as needed based on the results of the sound source verification test (see below).

Table 1. Summary of distance to NMFS sound level thresholds.

Source	Source Level	190 dB radius	180 dB radius	160 dB radius
440-cubic-inch airgun array	221.08 dB re 1 μPa (rms)	50 m	182 m	3.05 km
1,760-cubic-inch airgun array	236.55 dB re 1 μPa (rms)	880 m	1.84 km	6.83 km

3. SOUND SOURCE VERIFICATION

Sound source verification (SSV) tests on the same airgun arrays proposed for 2015 surveys were conducted by Heath *et al*. (2014) during SAE's Cook Inlet operations for SAE. The results of that SSV were used to estimate distances to the NMFS noise thresholds. SSVs for the vessels proposed to be used during the 2015 Cook Inlet operations were also conducted by Aerts (2008) in 2008. No additional SSVs are planned.

4. VESSEL-BASED VISUAL MONITORING

The purpose of the 4MP and PSOs and is compliance with regulations set in place by NMFS. The IHA describes measures to ensure disturbance of and effects on marine mammals is minimized and documented. This will be accomplished through a vessel-based visual monitoring program. PSOs will implement this program as specified in the NMFS-issued IHA and in this 4MP. The primary purposes of the vessel-based program are:

- Monitor: Observe the appropriate harassment and safety zones for marine mammals, estimate the numbers of marine mammals exposed to sound pulses and their reactions (where applicable), and document those incidents as required.
- Mitigate: Implement methodologies to include; clearing and ramp-up measures; observe for and detect marine mammals within, or about to enter the applicable safety radii; and implement necessary shut-down, power-down and/or speed/course alteration mitigation procedures when applicable, and; advise seismic crews of mitigation procedures.

Vessel-based monitoring objectives are:

- Ensure disturbance to marine mammals is minimized and all permit stipulations are satisfied;
- Document the effects of the proposed seismic activities on marine mammals; and
- Collect data on the occurrence and distribution of marine mammals in the proposed project area.

Monitoring activities will be scheduled to maximize marine mammal observations on/near the seismic vessels during all ongoing operations, including air-gun ramp-up activities. PSOs will conduct monitoring during all daylight periods (weather permitting) during seismic operations, and during most daylight periods when seismic operations are not occurring.

Vessel-based visual monitoring is designed to provide:

- The basis for real-time mitigation, as necessary and required by the IHA;
- Information used to " Level B takes" of marine mammals by harassment as required by NMFS;
- Data on occurrence, distribution, and activities of marine mammals from areas where seismic operations are conducted; and
- Data for the analysis of marine mammal distribution, movement and behavior relative to seismic activity (active and inactive).

4.1 Protected Species Observers

Seismic and mitigation vessels are suitable platforms for marine mammal observations. PSOs stationed on the flying bridge will have an unobstructed view around the entire vessel. If surveying from the bridge, the PSO's eye level will be about 4.6 meters (15 feet) above sea level.

SAE will hire a team of qualified PSOs. These PSOs will be stationed aboard all seismic and mitigation vessels to implement the 4MP and ensure the appropriate measures are conducted during all daytime seismic operations. Senior PSOs will be assigned as leaders on each vessel and will ensure effective communication between and among all PSOs, vessel and SAE personnel. A single senior PSOs will be assigned to oversee all 4MP mandates and function as the on-site person-in-charge (PIC).

At least two PSOs will be stationed on each of the two source vessels and the mitigation vessel for full coverage of the safety/harassment zones. Twenty-four hour PSO support is not needed since seismic operations do not exceed 8 to 10 hours per day. These seismic events are broken into three or four periods for up to 3 hours each. PSOs will therefore work on a rotational basis with shifts of 4 to 6 hours. Overall work days should not exceed 12 hours. However, sufficient numbers of PSOs will be available and provided to meet established standards.

4.2 PSO Role and Responsibilities

Roles and responsibilities of all PSOs constitute three integral parts:

1. Accurately observe and record sensitive wildlife species;
2. Follow monitoring and data collection procedures; and
3. Ensure mitigation measures are followed.

PSOs will be stationed at the best available vantage point on the source and mitigation vessels (flying bridge or bridge) which allows an unobstructed 360-degree view of the water. PSOs will scan systematically with the unaided eye and 7x50 reticle binoculars and supplemented with 40x80 long-range binoculars. New PSOs will be paired with PSOs with previous marine mammal monitoring experience to ensure the quality of marine mammal observations and data recording are consistent.

During periods when visual survey conditions are not conducive (not possible due to environmental conditions such as high sea state, fog, ice, and low light) to effectively monitor the designated applicable exclusion zone, SAE will operate a 0.16-liter (10-cubic-inch) mitigation gun. Continued operation of the mitigation gun is intended to alert marine mammals to the presence of the seismic guns in the area, thereby allowing them to clear the area before ramping the airguns up to noise levels that might be harmful.

All field data collected will be entered by the end of the day into a custom database using a notebook computer. Weather data relative to viewing conditions will be collected hourly, on rotation, and when sightings occur and include:

- Beaufort Sea State
- Wind speed and direction
- Sun position
- Percent glare

The following data will be collected for all marine mammal sightings:

- Bearing and distance to the sighting;
- Species identification;
- Behavior at the time of sighting (*e.g.*, travel, spy-hop, breach, etc.);
- Direction and speed relative to vessel;
- Reaction to activities – changes in behavior (*e.g.*, none, avoidance, approach, paralleling, etc.);
- Group size;
- Orientation when sighted (*e.g.*, toward, away, parallel, etc.);
- Closest point of approach;
- Sighting cue (*e.g.*, animal, splash, birds, etc.);
- Physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals;
- Time of sighting;

- Location, speed, and activity of the source and mitigation vessels, sea state, ice cover, visibility, and sun glare; and positions of other vessel(s) in the vicinity, and;
- Mitigation measure taken – if any.

PSOs will monitor continuously during daylight hours when seismic activities may occur and for a minimum of 30 minutes prior to the planned start of airgun or pinger operations and after an extended shut down. If marine mammals are sighted within designated injury exclusion zones or disturbance exclusion zones, airgun operations will either not begin or shut down immediately. SAE vessel crews and operations personnel will also watch for marine mammals (insofar as practical) to assist and alert PSOs for airgun shut-down if marine mammals are observed in or about to enter the exclusion zone.

Termination of seismic operations will be at the discretion of the PIC or designated PSO based on continual observation of environmental conditions and communication with other PSOs.

All observations and airgun shut-downs will be recorded in a standardized format and data entered into a custom database using a notebook computer. Accuracy of all data will be verified daily by the PIC or designated PSO by a manual verification. These procedures will reduce errors, allow the preparation of short-term data summaries, and facilitate transfer of the data to statistical, graphical, or other programs for further processing and archiving.

5. SHORE-BASED MONITORING

Shore-based monitoring for beluga whales will occur as a mitigation measure during any summer seismic surveys occurring nearshore within Cook Inlet beluga designated Critical Habitat Area 1. The standard operating procedures will be virtually identical to vessel-based monitoring, other than the PSOs will be stationed at promontory land locations near the seismic activity. The primary role of the shore-based PSOs is to alert vessel-based PSOs, via radio, of local beluga whale movements, especially movements towards the seismic activities and safety zones. Monitoring station locations and specific procedures will be defined once the 2015 seismic survey area is specifically defined.

6. MITIGATION MEASURES

There are several mitigation measures which will be employed to ensure no Level A or Level B "takes" of marine mammals occur. These include course alteration, ramp-up, complete shut-down, and power-down procedures.

6.1 Ramp-up Procedure

A "ramp-up" procedure gradually increases airgun volume at a specified rate and involves a step increase in the number and total volume of airguns until the full volume is achieved. The purpose of the ramp-up or "soft start" is to warn marine mammals potentially in the area and provide sufficient time for them to leave the project area and avoid any potential injury. Ramp-up is used at the start of airgun operations, including a power-down, shut-down, and after any period greater than 10 minutes in duration without airgun operations. The airgun array begins operating after a specified-duration period without airgun operations. The rate of ramp up will be no more than 6 dB per 5-minute period. Ramp up will begin with the smallest gun in the array that is being used for all airgun array configurations. During the ramp-up, the applicable exclusion zone for the full airgun array will be maintained.

If the complete applicable exclusion zone has not been visible for at least 30 minutes prior to the start of operations, ramp-up will not start unless the mitigation gun has been operating during the interruption of seismic survey operations. This means that it will not be permissible to ramp-up the full source from a complete shut-down in thick fog or at other times when the outer part of the applicable exclusion zones are not visible without operation of the 0.16-liter (10-cubic-inch) mitigation gun.

It will not be permissible to commence ramp-up if the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime and not commence ramp-up at night unless the seismic source has maintained a sound source pressure level at the source of at least 180 dB during the interruption of seismic survey operations.

6.2 Speed or Course Alteration

Whenever a marine mammal is seen outside the exclusion zone radius and based on its position and motion relative to the ship track is likely to enter the exclusion zone, PSOs can request that the seismic operations alter ship speed or track. If a marine mammal is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or course can be changed if safety the ship's crew is not compromised. This can be used in coordination with a power-down procedure. The marine mammal activities and movements relative to the seismic and support vessels will be closely monitored to ensure that the marine mammal does not approach within the applicable exclusion zone. If the mammal appears likely to enter the exclusion zone, further mitigation actions will be taken; for example, either further course alterations, power down, or shut down of the airgun.

As an additional mitigation procedure, with or without seismic operations taking place, SAE proposes to reduce vessel speed when within 1 kilometer of whales and those vessels capable of steering around such groups will do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group. Vessel captains will avoid multiple changes in direction and speed when within 1 kilometer of whales.

6.3 Power-Down Procedure

Whenever a marine mammal is detected outside the exclusion zone radius and based on its position and motion relative to the ship track is likely to enter the exclusion zone, PSOs may request that the seismic operations implement a power-down (de-energize the airgun array). A power-down procedure involves reducing the number of airguns in use such that the radius of the 180 dB (or 190 dB) zone is decreased to the extent that marine mammals are not in the exclusion zone. Alternatively, a shutdown procedure occurs when all airgun activity is suspended. During a power-down, a mitigation airgun (airgun of small volume such as the 10 cu in) is operated. If a marine mammal is detected outside the safety radius (either injury or harassment) but is likely to enter that zone, the airguns may be powered down before the animal is within the safety radius, as an alternative to a complete shutdown.

Similar to a shutdown, after a power down, airgun activity will not resume until the marine mammal has cleared the applicable exclusion zone. The animal will be considered to have cleared the applicable exclusion zone if it:

- Is visually observed to have left the applicable exclusion zone, or
- Has not been seen within the zone for 15 min in the case of pinnipeds, or
- Has not been seen within the zone for 30 min in the case of cetaceans.

6.4 Shut-Down Procedure

A shut-down occurs when all airgun activity is suspended. Active air guns will be shut down completely if a marine mammal approaches the applicable exclusion zone. The shutdown procedure will be accomplished within several seconds (of a "one shot" period) of the determination that a marine mammal is either in or about to enter the applicable exclusion zone.

Airgun activity will not proceed until the marine mammal has cleared the zone and the PSOs on duty are confident that no marine mammals remain within the appropriate exclusion zone. The animal will be considered to have cleared the exclusion zone if it:

- Is visually observed to have left the applicable exclusion zone;
- Has not been seen within the zone for 15 min in the case of pinnipeds; or
- Has not been seen within the zone for 30 min in the case of cetaceans.

7. REPORTING

7.1 Weekly Reports

Weekly reports will be submitted to NMFS no later than the close of business (Alaska Time) each Thursday during the weeks when in-water seismic activities take place. The field reports will summarize species detected, in-water activity occurring at the time of the sighting, behavioral reactions to in-water activities, and the number of marine mammals taken.

7.2 Monthly Reports

Monthly reports will be submitted to NMFS for all months during which in-water seismic activities take place. The monthly report will contain and summarize the following information:

- Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort Sea state and wind force), and associated activities during all seismic operations and marine mammal sightings.
- Species, number, location, distance from the vessel, and behavior of any sighted marine mammals, as well as associated seismic activity (number of power-downs and shutdowns), observed throughout all monitoring activities.
- An estimate of the number (by species) of: (i) pinnipeds that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 µPa (rms) and/or 190 dB re 1 µPa (rms) with a discussion of any specific behaviors those individuals exhibited; and (ii) cetaceans that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 µPa (rms) and/or 180 dB re 1 µPa (rms) with a discussion of any specific behaviors those individuals exhibited.
- A description of the implementation and effectiveness of the: (i) terms and conditions of the Biological Opinion's Incidental Take Statement; and (ii) mitigation measures of the IHA. For the Biological Opinion, the report shall confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on ESA-listed marine mammals.

7.3 90-Day Technical Report

A report will be submitted to NMFS within 90 days after the end of the project or at least 60 days before the request for another Incidental Take Authorization for the next open water season to enable NMFS to incorporate observation data into the next Authorization. The report will summarize all activities and monitoring results (*i.e.*, vessel and shore-based visual monitoring and aerial monitoring) conducted during in-water seismic surveys. The Technical Report will include the following:

- Summaries of monitoring effort (*e.g.*, total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals).

- Analyses of the effects of various factors influencing detectability of marine mammals (*e.g.*, sea state, number of observers, and fog/glare).
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.
- Analyses of the effects of survey operations.
- Sighting rates of marine mammals during periods with and without seismic survey activities (and other variables that could affect detectability), such as: (i) initial sighting distances versus survey activity state; (ii) closest point of approach versus survey activity state; (iii) observed behaviors and types of movements versus survey activity state; (iv) numbers of sightings/individuals seen versus survey activity state; (v) distribution around the source vessels versus survey activity state; and (vi) estimates of take by Level B harassment based on presence in the 160 dB harassment zone.

7.4 Notification of Injured or Dead Marine Mammals

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA (if issued), such as an injury (Level A harassment), serious injury or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), SAE would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the Alaska Regional Stranding Coordinators. The report would include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Activities would not resume until NMFS is able to review the circumstances of the prohibited take. NMFS would work with SAE to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SAE would not be able to resume their activities until notified by NMFS via letter, email, or telephone.

In the event that SAE discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition as described in the next paragraph), SAE would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators. The report would include the same information identified in the paragraph above. Activities would be able to continue while NMFS reviews the circumstances of the incident. NMFS would work with SAE to determine if modifications in the activities are appropriate.

In the event that SAE discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the IHA (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), SAE would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators, within 24 hours of the discovery. SAE would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network.

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APPENDIX C

Plan of Cooperation

Cook Inlet 3D

SAExploration, Inc. October 2014

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1. INTRODUCTION

SAExploration, Inc. (SAE) is planning a 2-year multi-client seismic project within the Cook Inlet. This Plan of Cooperation (POC) will be used by SAE to avoid and or minimize conflicts with subsistence activities by open communications and interaction with the members of affected communities. SAE believes that the understanding the issues important to the communities in which we operate are vital to solid community relations. SAE will do its best to accommodate the different cultures, lifestyles, heritage and preferences in these communities.

This plan contains three phases:

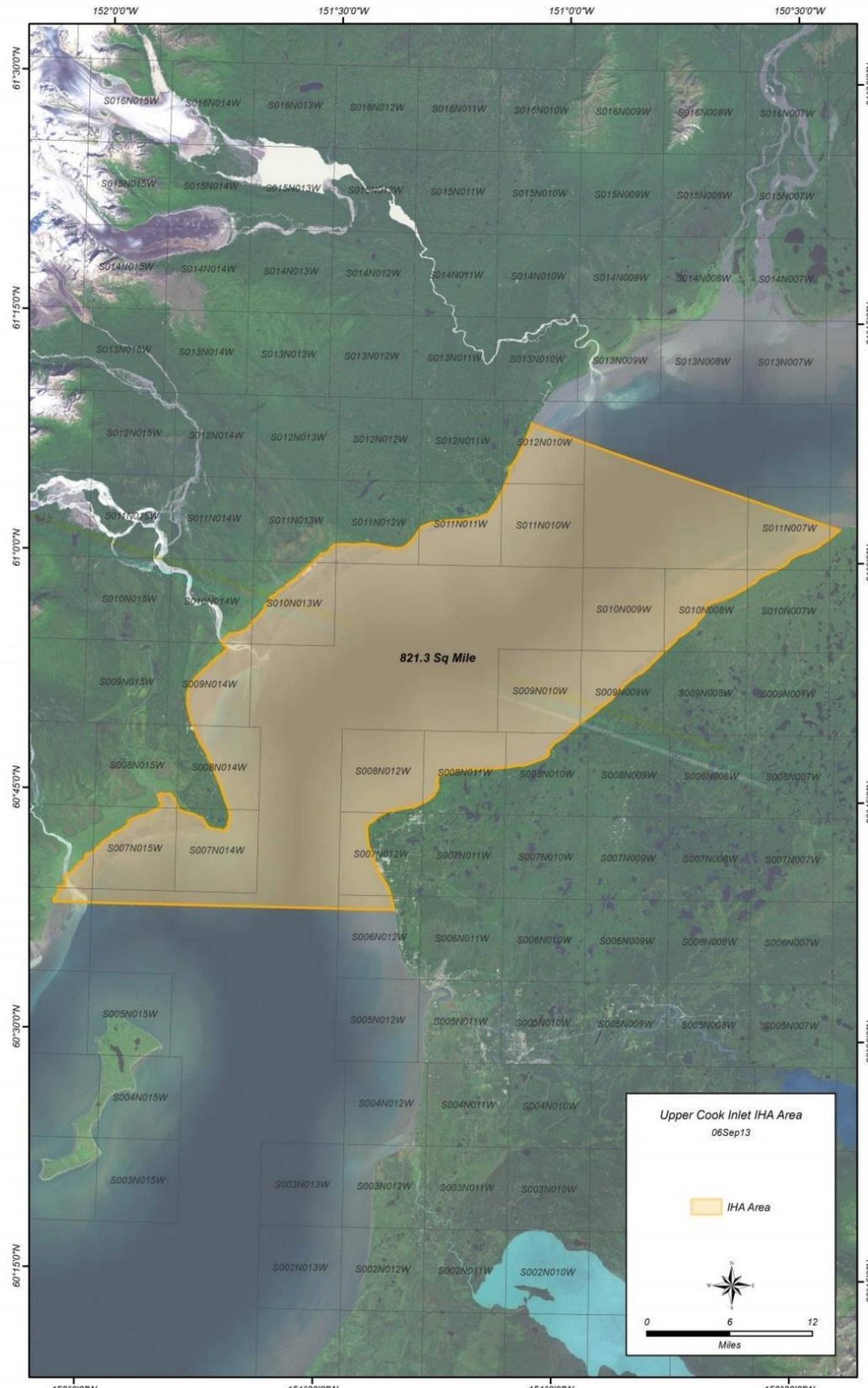
- Phase one describes initial steps to establish communication and understand subsistence timing prior to the program.
- Phase two describes how communication will happen during the program. This communication will keep SAE up to date regarding the timing and status of subsistence hunts and our liaison with the communities.
- Phase three describes what to do in the event that activities may affect subsistence activities and how to communicate with subsistence user groups.

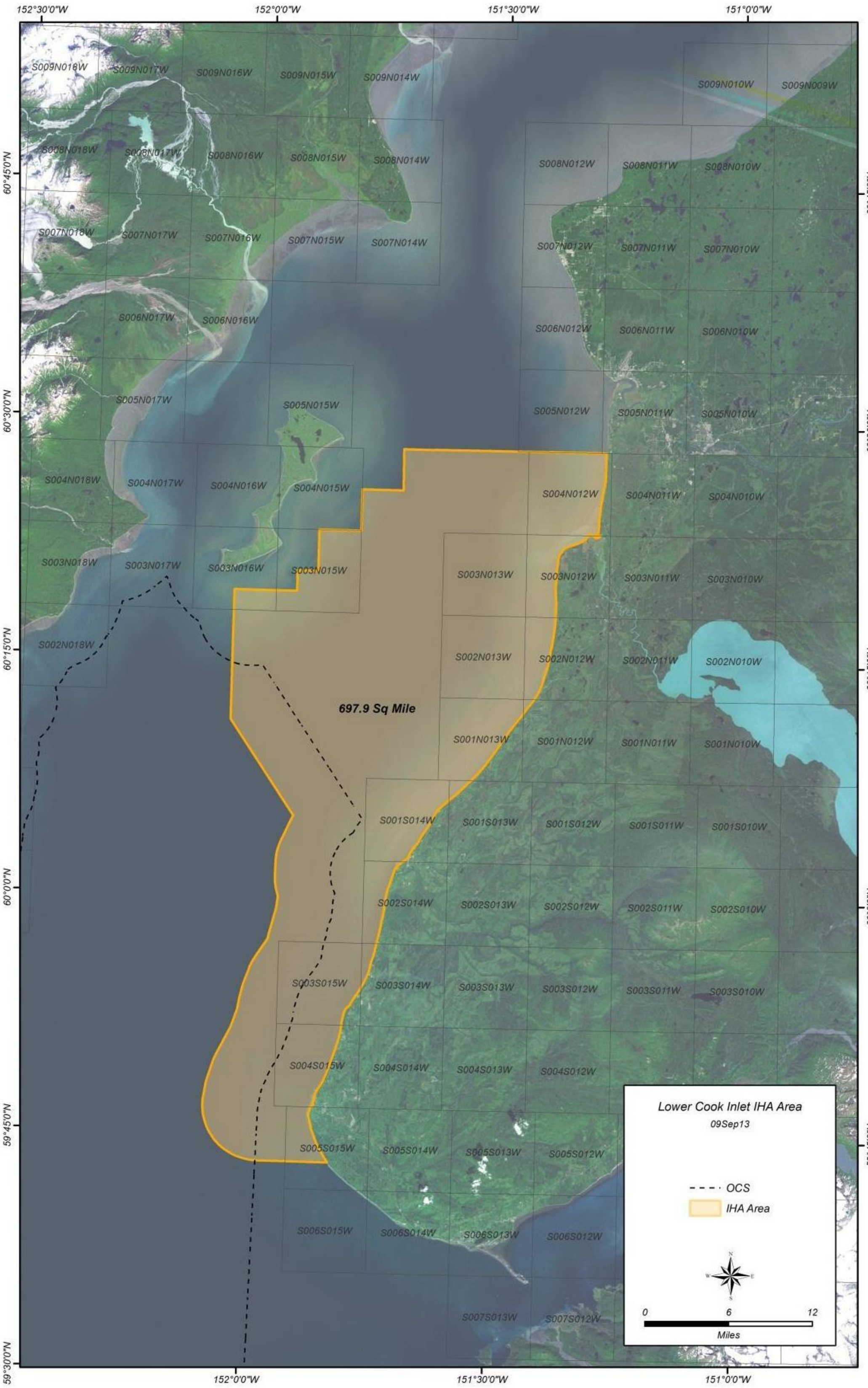
2. PROJECT DESCRIPTION

The purpose of the proposed survey is to replace and augment existing datasets by providing better quality, higher resolution seismic data by using autonomous nodal seismic recording equipment.

The project will conduct a three dimensional (3D) ocean bottom seismic survey in the upper and lower Cook Inlet area during 2015. The program will be conducted within the months of late March to mid-December, possible starting in the upper Cook Inlet in spring/summer of 2015. This time period includes all activities; mobilization, marine layout activities, marine data acquisition and demobilization of equipment and crews. Project operations will include state and federal waters.

AREAS OF ACTIVITY




Lower Cook Inlet IHA Area
09Sep13
OCS
IHA Area
697.9 Sq Mile
0
6
12
Miles
152°30'0"W
152°0'0"W
151°30'0"W
151°0'0"W
60°45'0"N
60°30'0"N
60°15'0"N
60°0'0"N
59°45'0"N
59°30'0"N

3. COMMUNICATION

As part of this plan, SAE will communicate with the following groups as the project enters each area:

- Village Corporations
- Native Corporations
- Community sports fishing groups
- Commercial fishing groups
- Chamber of Commerce
- Community meetings
- The Kenai Peninsula Fishermen's Association

During these meetings SAE will take the opportunity to add other organizations to the list that they learn about from community suggestions.

4. PLAN

4.1 Phase One

Prior to offshore activities SAE will consult with nearby communities such as Nikiski, Tyonek, Ninilchik, Anchor point. SAE plans to attend and present the program description to the different groups listed in Section 3 prior to operations within those areas. During these meetings discussions will include our project description, maps of project area and resolutions of potential conflicts. These meetings will allow SAE to understand community concerns, and requests for communication or mitigation. Additional communications will continue throughout the project. Meetings will also be held with Native Corporation leaders to establish subsistence activities and timelines. Ongoing discussions and meeting with federal and state agencies during the permit process.

A specific meeting schedule has not been finalized, but meetings with the entities identified in Section 3 will occur between December 2014 and March 2015.

4.2 Phase Two

SAE will document results of all meetings and incorporate to mitigate concerns into the Plan of Cooperation (POC). There shall be a review of permit stipulations and a permit matrix developed for the crews. The means of communications and contacts list will be developed and implemented into the project. The use of PSOs/MMO’s on board the vessels will ensure that appropriate precautions are taken to avoid harassment of marine mammals.

4.3 Phase Three

If a conflict does occur with project activities involving subsistence or fishing, the project manager will immediately contact the affected party to resolve the conflict. If avoidance is not possible, the project manager will initiate communication with the Operations Supervisor to resolve the issue and plan an alternative course of action. The communications will involve the Permits Manager and the Anchorage Office of SAE.

5. EMPLOYMENT OPPORTUNITIES

SAE and its contractors work with local communities and villages to identify qualified individuals that are interested in working on our program.

6. CONTACTS

The following contact information is provided to facilitate communication.

- SAExploration
  Rick Stolz, Operations Supervisor 907-330-9662
  Sue Simonds, Permits and Regulatory Manager 907-331-8140
  Rick Trupp, General Manager 907-522-4499 (o), 907-280-9442 (m)
- Protective Species Observers
  TBD
- PSO’s/MMO’s
  TBD